EXHIBIT B

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF TENNESSEE
CHATTANOOGA DIVISION

VINCENT SYSTEMS GMBH, *Plaintiff,* v. FILLAUER COMPANIES, INC. and MOTION CONTROL, INC., *Defendants.*	Case No: 1:23-CV-00002-CEA-SKL

DECLARATION OF PINHAS BEN-TZVI IN SUPPORT OF DEFENDANTS' PROPOSED CLAIM CONSTRUCTIONS

I, Pinhas Ben-Tzvi, hereby declare that the following is true and correct. I am over the age of 18, competent to make this declaration, and have personal knowledge of the facts set forth below. If called to testify, I could and would testify honestly, under oath, to the matters set forth herein.

I. INTRODUCTION

1. I was retained on behalf of Motion Control, Inc. ("Motion Control"), as a technical expert in this proceeding before the United States District Court for the Eastern District of Tennessee. I have been asked to consider certain claim terms from the U.S. Patent No. 8,491,666 ("the '666 Patent") and to opine as to the meaning of the terms from the perspective of a Person Having Ordinary Skill in the Art ("PHOSITA").

2. I am not an attorney, and I have not been asked to offer any legal opinions. I have been informed and understand the law to be applied for claim construction, which I explain in places below. I have applied the law told to me in developing my technical opinions in this declaration.

II. BACKGROUND AND QUALIFICATIONS

a. Education and Work Experience

3. I have attached, as Exhibit A, a copy of my Curriculum Vitae, which outlines my educational and employment history.

4. In 2000, I received a Bachelor of Science degree in Mechanical Engineering from the Technion—Israel Institute of Technology. I also received a master's degree in mechanical engineering from the University of Toronto in 2004 and obtained a Ph.D. in Mechanical Engineering from the University of Toronto in 2008. I have authored numerous technical books and articles in the field. *See* Ex. A. I've authored over 180 peer-reviewed articles in the field of engineering design and various mechanisms, including robotic exoskeletons for rehabilitation and therapy, and various biomechanical devices.

5. I am currently a Professor in the Department of Mechanical Engineering at Virginia Tech in Blacksburg, Virginia. I am a tenured Professor of Mechanical Engineering and Electrical and Computer Engineering, and Founder and the Director of the Robotics and Mechatronics Lab at Virginia Tech. I am also a licensed Professional Engineer (P.E.).

6. I am currently also a Program Director for the Established Program to Stimulate Competitive Research (EPSCoR), Office of Integrative Activities (OIA), Office of the Director (OD), National Science Foundation (NSF), Alexandria, VA on an Intergovernmental Personnel Act (IPA) assignment as detail to NSF. My views in this declaration are my own, and do not represent the NSF in any way or form.

7. I am the named inventor on at least twelve U.S. patents and patent applications and a Canadian patent directed to various electromechanical devices.

8. My expertise includes and interests span the areas of cyber-physical systems,

artificial intelligence, machine learning, robotics and intelligent autonomous systems, healthcare technologies, human-machine/robot interactions, multi-robot systems, systems dynamics and automated control systems and automation, mechatronics design, novel sensing and actuation, mechanical design, mechanism design, machine design, and product development and integration. I have additional knowledge in mobile robotics for military and police applications, microprocessor-based applications, and computer aided design (CAD).

9. In my many years of engineering, manufacturing, and product development experience, I have personally been involved in the design of many types of electromechanical products, including many designs using drivers (e.g., gas pistons or springs, hydraulic drivers, electro-mechanical drivers/linear actuators). I am intimately familiar with the technology in this case.

10. I am an experienced mechanical/electromechanical design engineer and technical expert with extensive experience with various types of drivers, linear motion control, and ergonomic industrial design. I have about 25 years of combined industrial and academic experience in mechanical design, testing, prototyping, developing, and machine/mechanism design, synthesis, analysis, manufacturing and integration. I have held numerous other positions in my about 25 years in the engineering field, as shown on my curriculum vitae. Not all have been discussed in detail in my declaration. My background demonstrates an expertise and strong understanding of prosthetics and robotics. Additionally, a list of cases in which I have provided testimony in the last five years is attached as Exhibit B.

b. Engagement

11. For present purposes, I have been asked to consider the ‘666 Patent and related evidence in this case and provide my independent opinions, from the perspective of a PHOSITA

at the time of the alleged invention, as to the proper understanding of certain disputed claim terms and limitations.

12. Although I am being compensated for my services in this matter at my standard consulting rate of $560 per hour, my compensation is not contingent upon the opinions I render or the outcome of this proceeding. I have no financial interest in any of the parties, and I have no other interest in this proceeding.

13. This report is based on information currently available to me. I reserve the right to amend or supplement my analysis in this report and/or to respond to any additional submissions prepared by or on behalf of Vincent. I also reserve the right to amend or supplement my opinions based on further discovery and information provided in the case.

14. I reserve the right to create any additional summaries, tutorials, demonstrations, charts, drawings, tables, and/or animations that may be appropriate to supplement and demonstrate my opinions as necessary.

15. All of the opinions stated in this report are based on my own personal knowledge and professional judgment.

III. MATERIALS CONSIDERED

16. I have reviewed a number of materials in support of my opinions contained herein. A list of those materials is attached as Exhibit C.

17. It is my understanding that discovery is yet ongoing. Should any additional information be brought to my attention between now and the time of any hearing or trial, I reserve the right to supplement the statements, conclusions and opinions set forth in this report to address such information.

18. If asked to testify at any hearing or at trial in this case, I would expect to refer to

the information and items that I have considered in preparing this report as well as any exhibits presented by the parties including demonstrative exhibits to the extent that such exhibits are presented. If requested, I further reserve the right to provide a tutorial or demonstration to the court or jury on the art, technology or opinions discussed in this report.

IV. LEGAL PRINCIPLES

a. Level of Ordinary Skill in the Art

19. I have been informed that patents are considered from the perspective of a person having ordinary skill in the art, and that this is a hypothetical person who is presumed to know the relevant prior art, thinks along conventional wisdom in the art, and is a person of ordinary creativity. I understand that this hypothetical PHOSITA is considered to have the normal skills and knowledge of a person in the technical field.

20. I have been informed that the following five factors inform the analysis for determining the level of ordinary skill in the art: (1) type of problems encountered in the art; (2) prior art solutions to those problems; (3) rapidity with which innovations are made; (4) sophistication of the technology; and (5) educational level of active workers in the field. I have also been informed that in a given case, every factor may not be present, and one or more factors may predominate. *In re GPAC Inc.*, 57 F.3d 1573, 1579 (Fed. Cir. 1995).

21. I have knowledge relevant to what a person having ordinary skill in the art at the time of the invention would understand and do. In 2008, at the priority date of the ’666 Patent, I had almost a decade of experience in this field and was a person having ordinary skill in the art.

22. The field of the invention here is prosthetic devices, and more specifically, the fingers of prosthetic hands. Traditionally, prosthetics are aimed at replicating basic limb structures to restore some level of physical function. The emphasis in the early ages of prosthetics was

primarily on mechanical designs, offering limited dexterity and sensory feedback. However, with the invention of robotics and advancements in mechatronics, the field of prosthetics has undergone a paradigm shift towards more sophisticated and technologically integrated solutions. The integration of robotics into prosthetic fingers represents a marked departure from conventional designs, introducing a new era of functionality and adaptability.

23. Prosthetics and robotics are closely related fields due to their shared focus on enhancing and restoring human mobility and functionality. Prosthetics involve the design and creation of artificial limbs or body parts to replace those lost or impaired due to injury, illness, or congenital conditions. Robotics, on the other hand, encompasses the development of intelligent machines using design principles that are being adapted in the design of prosthetic devices. The intersection of these fields occurs in the development of robotic prosthetics, where advanced robotics technology is integrated into artificial limbs. This synergy allows for the creation of prosthetic devices that can mimic natural movements, respond to neural signals, and provide users with a more seamless and functional experience. The incorporation of robotics into prosthetics contributes to improved mobility, enhanced adaptability, and a closer approximation to natural human movement.

24. Modern robotic prosthetic fingers leverage advanced sensor technologies, artificial intelligence, and intricate control systems to replicate the intricate movements and tactile sensations of natural fingers. These innovations are informed by a deeper understanding of biomechanics and neural interfaces, allowing for more intuitive and responsive prosthetic control. Neural interfaces, for instance, enable direct communication between the prosthetic device and the user's nervous system, translating neural signals into precise and coordinated movements. Furthermore, the incorporation of robotics in prosthetic fingers has facilitated the development of

versatile grip patterns and the ability to manipulate objects with varying shapes and sizes. This increased dexterity is particularly crucial in enhancing the user's overall quality of life by enabling a more natural and nuanced interaction with the environment.

25. In recent years, the field has seen a surge in research and development, leading to prosthetic fingers that not only mimic the form but also the function of natural fingers. Artificial intelligence algorithms contribute to predictive and adaptive control mechanisms, allowing the prosthetic to anticipate user intentions and adjust its movements accordingly.

26. It is my opinion that a PHOSITA relating to the subject matter of the ’666 Patent would have an engineering or design background and experience designing, developing, manufacturing, and studying the types of mechanisms found in prosthetic devices or robotic exoskeletons, or other similar mechanisms. More particularly, a hypothetical PHOSITA would be a person with at least a bachelor’s degree in engineering or a similar technical degree or equivalent work experience and at least about 3-5 years’ experience designing, developing, manufacturing, or studying the types of mechanisms found in prosthetic devices or robotic exoskeletons, or other similar mechanisms.

27. I have about 25 years of combined industrial and academic experience in product design, testing, prototyping, developing, machine/mechanism design, synthesis, analysis, manufacturing, and integration, including development of robotic exoskeletons and various precision mechatronic and robotic devices for medical applications. I would consider myself to be a PHOSITA of the field of technology of the Asserted Patent, and I certainly would understand how a PHOSITA would interpret or understand the Asserted Patent.

b. Claim Construction

28. The following reflects my understanding of the principles of claim construction:

The words of a claim "are generally given their ordinary and customary meaning." *Phillips v. AWH Corp.*, 415 F.3d 1303, 1313 (Fed. Cir. 2005) (*en banc*). This is the meaning that the term would have to a person of ordinary skill in the art in question at the time of the invention. *Id.*

29. “The person of ordinary skill in the art is deemed to read the claim term not only in the context of the particular claim in which the disputed term appears, but in the context of the entire patent, including the specification.” *Id*. “The specification is always highly relevant to the claim construction analysis.” *Id*. at 1315 (quotation marks omitted). “Usually, it is dispositive; it is the single best guide to the meaning of a disputed term.” *Id*. (internal citation and quotation marks omitted).

c. Intrinsic and Extrinsic Evidence

30. I have been informed by counsel that the claims of an issued patent must be read in light of the patent specification, and that the specification is the single best guide to the meaning of a disputed term. I have also been informed that the prosecution history can inform the meaning of the claim language by demonstrating how the inventor and the United States Patent and Trademark Office understood the invention. I have also been informed that, if a claim term has a commonly understood meaning to those in the field, then that plain meaning is how the claim term should be construed in the absence of evidence to the contrary.

31. I have been informed by counsel that evidence to the contrary may be either intrinsic evidence (evidence contained within the prosecution history of the patent itself) or extrinsic evidence (everything else, such as dictionary definitions). I have been informed that the strongest evidence of a claim term’s meaning is the words of the claim itself and the context in which the claim term is used, followed by any definition or explanation given in the patent’s specification, followed by any definition or explanation given in the patent’s prosecution history.

I have been informed that other claims, either asserted or unasserted, can also be valuable sources for claim construction. For example, differences among claims can be a useful guide in understanding a claim term's meaning.

32. I have been informed by counsel that extrinsic evidence is evidence from outside the patent's prosecution history, which may include expert testimony, other literature defining the term or terms, and the like. I have been informed by counsel that dictionary definitions are also extrinsic evidence, although they may be used to inform what the plain and ordinary meaning of a claim term is.

d. Indefiniteness

33. As I understand the Patent Act, Section 112(b) requires a patent specification "conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention." 35 U.S.C. § 112(b). Because of this statutory requirement, if a claim fails to particularly point out and distinctly claim the invention, the claim is indefinite and thus invalid. "[A] patent is invalid for indefiniteness if its claims, read in light of the specification delineating the patent, and the prosecution history, fail to inform, with reasonable certainty, those skilled in the art about the scope of the invention." *Nautilus, Inc. v. Biosig Instruments, Inc.*, 134 S.Ct. 2120, 2124 (2014). Whether a claim is invalid for indefiniteness requires determining whether a skilled artisan would understand what is claimed when the claim is read in view of the specification. *Morton Int'l, Inc. v. Cardinal Chem. Co.*, 5 F.3d 1464, 1470 (Fed. Cir. 1993).

34. "Because claims delineate the patentee's right to exclude, the patent statute requires that the scope of the claims be sufficiently definite to inform the public of the bounds of the protected invention, i.e., what subject matter is covered by the exclusive rights of the patent."

Halliburton Energy Servs., Inc. v. M-I LLC, 514 F.3d 1244, 1249 (Fed. Cir. 2008) (citing *Athletic Alternatives, Inc. v. Prince Mfg., Inc.*, 73 F.3d 1573, 1581 (Fed. Cir. 1996)); *Morton Int'l, Inc.,* 5 F.3d at 1470. Claim language cannot be "ambiguous, vague, incoherent, opaque, or otherwise unclear in describing and defining the claimed invention." *In re Packard,* 751 F.3d 1307, 1311 (Fed. Cir. 2014). A claim must be comprehensible to the ordinary skilled artisan and precise enough to provide clear notice of what is claimed; otherwise, the claims are indefinite. *Nautilus*, 134 S.Ct. at 2129 (quoting *Markman v. Westview Instruments, Inc.,* 517 U.S. 370, 373 (2002)).

35. When a person of skill in the art would be unable to determine objective boundaries of a claim limitation, the claim is invalid for indefiniteness. *See Berkheimer v. HP Inc.,* 881 F.3d 1360, 1363-64 (Fed. Cir. 2018) (the term "minimal redundancy" rendered claim indefinite when the specification provided "no point of comparison for skilled artisans to determine an objective boundary of 'minimal' …"); *In re Walter,* 698 F. App'x 1022, 1026-27 (Fed. Cir. 2017) (the term "block-like" was indefinite because "nothing in the intrinsic record offers 'objective boundaries' for ascertaining whether a given shape falls into either category [of 'block-like' or not]").

V. Overview of the '666 Patent

36. I have read and considered the '666 Patent, issued July 23, 2013, as well as its prosecution history.

37. I understand that the '666 Patent claims priority to a foreign application, specifically one filed in Germany on November 8, 2008 (DE 102 008 056 520). I also understand that the '666 Patent went through the Patent Cooperation Treaty ("PCT") filing process. As I understand it, the PCT filing process is a worldwide patent filing system that allows an inventor to file a single international application that will be recognized by each member country. Here, I understand Vincent, the applicant, filed an application with the German patent office (in the native

language) and in the national phase chose to submit an application to the USPTO on August 26, 2011. The USPTO examined the English-translated application and the amendments made during examination, and the ’666 Patent issued on July 23, 2013.

38. It is my understanding that the ’666 Patent relates, broadly speaking, to a finger element that can be used in an artificial single-finger-prosthesis or as a component of an artificial hand or arm-prosthesis. ’666 Patent at Abstract. It describes a finger element with a carrier component, a first phalanx, a second phalanx, a servo drive, and a coupling mechanism, as well as a worm gear with a threaded worm and a toothed segment. *Id.*

39. It is my opinion that numerous portions of the specification of the ’666 patent are unclear and ambiguous such that it is difficult, even for a PHOSITA, to understand what the Asserted Patent actually discloses and claims. As described more below, it is my opinion that the claims are indefinite, particularly as to the requirement of “***guided in axial direction by separate guidances***.” However, even as to other claim elements, the specification is riddled with awkward and unclear phrasings, typographical errors and a lack of detailed figures and descriptions, such that interpretation is extremely difficult. I have interpreted the meaning as I believe a PHOSITA would based on what is disclosed, to the best of my ability.

40. All the terms at issue and discussed in this declaration appear in Claim 1 of the ’666 Patent (emphasis added):

A finger element, comprising:

a) a carrier component
b) a first phalanx with a first hinge connection to the carrier component,
c) a second phalanx with a second hinge connection to the first phalanx,
d) ***a servo drive*** for the first hinge connection with a motor with a drive shaft and a worm gearing with a threaded screw and a cog segment that engages to the threaded screw, and
e) ***a coupling mechanism between the first hinge connection and the second hinge connection***, wherein
f) the threaded screw is supported on the drive shaft form fittingly and ***axially***

moveable as well as ***guided in axial direction by separate guidances***.

VI. State of the Art

41. One of the earliest prosthetic hand dates back to ancient civilizations, with early examples including simple wooden and metal limbs. These devices were often basic in design and aimed primarily at restoring a semblance of physical appearance rather than advanced functionality. During the Renaissance, there were notable improvements in prosthetic design, featuring more intricate craftsmanship. The Industrial Revolution saw the introduction of materials like leather and metal, enabling the production of more durable and adjustable prosthetic limbs.

42. The two World Wars marked significant milestones in prosthetic development. The demand for functional limbs for war veterans prompted innovations, leading to the creation of more functional and adjustable prosthetics. After World War II, advancements in materials and technology in the post-war era allowed for the development of more lightweight and realistic-looking prosthetics. However, these devices still lacked the sophisticated functionality seen in modern prosthetics. The integration of robotics into prosthetics gained momentum in the late 20th century. The application of mechatronics and advanced control systems enabled more natural and responsive movements.

43. As I previously discussed, prosthetics and robots are closely related fields due to their shared focus on enhancing and restoring human mobility and functionality. The convergence of prosthetics and robotics is evident in the shared objective of restoring or augmenting human functionality. This relationship has strengthened over the years due to several factors:

a. <u>Technological Integration</u>: Robotics has allowed for the incorporation of advanced sensors, actuators, and control systems into prosthetic devices, enabling more natural and intuitive movements.

b. Neural Interfaces: Developments in neural interfaces have facilitated direct communication between prosthetics and the human nervous system, enhancing the precision and responsiveness of prosthetic movements.

c. Biomechanical Understanding: Advancements in biomechanics and material science have contributed to the development of prosthetics that not only resemble natural limbs but also replicate their intricate movements and sensory feedback.

d. Artificial Intelligence: The integration of artificial intelligence algorithms has enabled prosthetics to adapt to users' intentions, providing a higher level of functionality and customization.

44. In conclusion, the history of prosthetics has witnessed a gradual progression from basic designs to sophisticated, technologically integrated solutions. The close relationship between prosthetics and robotics has been pivotal in driving these advancements, with innovations continually pushing the boundaries of what is possible in restoring and enhancing human mobility.

VII. PROPOSED CONSTRUCTIONS

a. "Servo drive"

Defendants' Proposed Construction	Plaintiff's Proposed Construction
A self-contained feedback system that controls mechanical movement	Plain and ordinary meaning

45. The term "servo drive" appears in limitation (d) of claim 1 of the '666 Patent: "***a servo drive*** for the first hinge connection with a motor with a drive shaft…."

46. "Servo drive" is a specific type of device that has, and had at the time of the invention, a customary meaning readily understood by a PHOSITA. A "servo drive" refers to a physical device comprised of both mechanical and electrical components. Although there are

several types of servo drives, they generally comprise a servo motor actuated by a servo controller. In other words, a servo motor is generally an electric motor controlled by a servo controller (i.e., an electronic circuit) so that continuous determination of precise position, speed, and torque can be made to more precisely control mechanical movement of the component the servo motor is driving. Servo drives are self-contained systems that monitor command signals (i.e., electrical signals) to continually adjust for deviations from expected mechanical movement and are therefore able to control mechanical movement using its self-contained or closed-loop feedback system. This feedback mechanism is the primary difference between a servo drive and actuators or simple electric motors, as the former is capable of positional control based on an input signal and the latter only recognizes "on" or "off" and are incapable of positional control.

47. Servo drives come in a variety of shapes and sizes, are suitable for applications across many industries including prosthetics and robotics, and are commercially available off-the-shelf. In a prosthetic hand—or more specifically, a prosthetic finger—the purpose of a servo drive is to control the speed, position, and torque of the motor in the finger and therefore the finger itself. Employing a servo drive in a prosthetic hand, as opposed to a basic actuator or motor, offers a heightened degree of sophistication crucial for replicating the intricate functions of the human hand. The precision control facilitated by servo drives is particularly vital in enabling nuanced movements, such as delicate grasping or manipulating objects with varying levels of force. One of the key advantages lies in the incorporation of feedback mechanisms, like encoders or sensors, ensuring continuous real-time monitoring and adjustment of finger positions. This not only enhances the accuracy of movements but also serves as a protective measure against potential damage to the prosthetic hand's delicate components. The efficient torque management inherent in servo drives is pivotal for delicate tasks, preventing excessive force that might otherwise

jeopardize the structural integrity of the prosthetic fingers. Moreover, the adaptability and responsiveness of servo drives make them versatile for a spectrum of activities, contributing significantly to user confidence and safety. In contrast, the absence of precise control and feedback in basic actuators or motors could compromise user comfort, potentially leading to unintended movements or discomfort. In essence, the implementation of servo drives in prosthetic hands represents a solution that aligns seamlessly with the complexities of human hand movements, prioritizing not only precision but also user safety and overall comfort in various functional scenarios.

48. The language of claim 1—"a servo drive for the first hinge connection with a motor with a drive shaft and a worm gearing with a threaded screw and a cog segment that engages to the threaded screw"—is consistent with the customary meaning of "servo drive" explained above. The servo drive uses a servo controller (i.e., an electronic circuit) to control the servo motor, which rotates a drive shaft which in turn rotates the threaded screw and cog segment, which causes actuation of the first hinge connection.

49. The specification does not define "servo drive" or use the term in a manner inconsistent with its plain and ordinary meaning. For example, the specification teaches a "servo ***drive encloses a motor*** with or without integrated gear transmission to a drive shaft." '666 Patent at 2:13-16 (emphasis added). It further describes "[t]he ***drive 11 encloses at least an electric motor as servo member*** …" '666 Patent at 4:9-10 (emphasis added). A PHOSITA would understand this description is of a standard servo drive that includes electronic circuitry to control the electric motor. The "electric motor" is described as a "servo member" because it is part of the servo drive 11 and claimed in claim 1.

50. The specification of the '666 Patent also describes an "optional tactile sensor"

integrated into the fingertip and/or core 15, and/or a resistance strain gauge attached to one of the phalanges. ‘666 patent at 4:19-21. If the “servo drive” of claim 1 is interpreted as only an electric motor without control circuitry (i.e., a servo controller), then there would be no reason to include a tactile sensor or resistance strain gauge as there would be no circuitry to receive the signals and factor them into the commands sent from the servo controller to the servo motor.

51. It is my opinion that Defendants’ proposed construction is consistent with a PHOSITA’s understanding of what a “servo drive” is, as well as well-understood definitions for “servo.” *See, e.g,* MC0006458; MC0006434; MC0006446; MC0006452; MC0006455.

52. It is my understanding that Vincent proposes “servo drive” be given its plain and ordinary meaning. I do not understand what Vincent means by the “plain and ordinary” meaning of this term or whether the parties have a dispute regarding its construction because I believe Defendants’ proposed construction of “servo drive” *is* the plain and ordinary meaning of the term as understood by a PHOSITA now and at the time of the claimed invention.

53. It is therefore my opinion that the term “servo drive” in Claim 1 of the ’666 Patent should be construed as “a self-contained feedback system that controls mechanical movement.”

b. “A coupling mechanism between the first hinge connection and the second hinge connection”

Defendants’ Proposed Construction	Plaintiff’s Proposed Construction
A component connecting and positioned within the space separating the first and second hinge connections	Plain and ordinary meaning

54. The term “a coupling mechanism between the first hinge connection and the second hinge connection” appears in limitation (e) of claim 1 of the ’666 Patent. To a PHOSITA this claim language denotes a mechanical relationship between components.

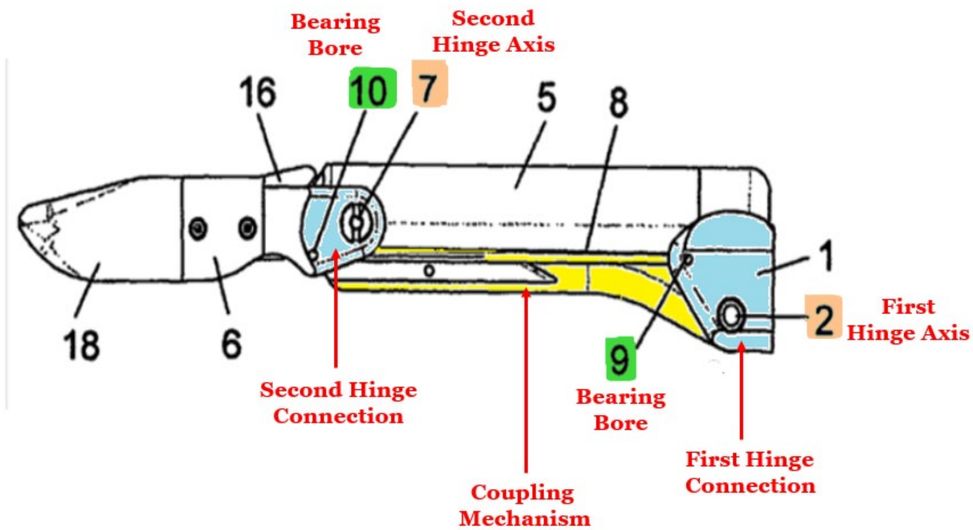
55. The purpose of any coupling mechanism is to connect at least two mechanical

components together. The plain meaning of the phrase "a ***coupling mechanism between*** the first hinge connection and the second hinge connection" would be understood by a PHOSITA as a mechanical component that is attached at one end to the first hinge connection and attached at the other end to the second hinge connection and extends within the space separating the first and second hinge connections. This interpretation is also consistent with general dictionary definitions of "coupling" and "between." *See, e.g.,* MC0006353-6355 ("coupling" defined as "[a] device that links or connects."); MC006356-6358 ("coupling" defined as "a device for connecting two parts or things"); MC0006368-6370 ("coupling" defined as "a device that serves to connect the ends of adjacent parts or objects"); MC0006371-6373 ("coupling" defined as "a flexible or rigid mechanical device or part for joining parts together, as two shafts"); MC0006332-6334 ("between" defined as "in or through the position or interval separating"; "connecting spatially"); MC0006335-6337 ("between" defined as "in the interval separating"; "in an intervening space or interval"); MC0006353-6355 ("between" defined as "in or through the space that separate (two things)"; "that connects or relates to"; "along a course that connects").

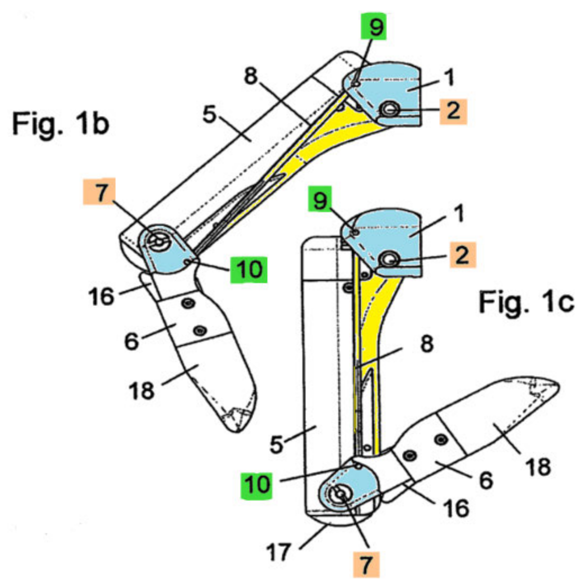
56. The '666 Patent teaches "a finger element with a carrier component, a first phalanx that is articulated thereon via a first hinge connection as well as a second phalanx that is articulated via a second hinge connections to the first phalanx." '666 Patent at 2:9-12. "[T]he finger element includes a coupling mechanism between the first and second hinge connection." *Id.* at 2:20-21. "The coupling mechanism consists further preferred of one or two spring bar connections … that engage eccentrically to the rotation axes of the first and second hinge connections to the respectively adjacent carrier components and second phalanx respectively." *Id.* at 3:6-11. The '666 Patent further explains that the "carrier component 1" has a "first hinge axis 2" that "serves at the same time as support of the gear segment and as rotation axis for the first phalanx 5." *Id.* at 3:40-

46. "The first phalanx 5 is in return connected with the second phalanx 6 via a second hinge connection, wherein the second hinge axis 7 forms the rotation axis for the second phalanx." *Id.* at 3:46-49. The "coupling mechanism encloses in the example embodiments two elastic spring bar connections 8 that are arranged in parallel to each other at both sides of the first phalanx 5, wherein the spring bar connections 8 each engage at the carrier component and at the second phalanx pivotably in an according bearing bore 9 and 10 respectively eccentrically to the first 2 and second 7 hinge axis respectively." *Id.* at 3:52-57.

57. In other words, as shown below in annotated Figure 1*a*, the first hinge connection (annotated in blue) has an axis of rotation at the first hinge axis 2 and is attached to one end of the coupling mechanism (annotated in yellow) at bearing bore 9, which is located "eccentrically" (i.e., off-center) to the first hinge axis 2. Similarly, the second hinge connection (annotated in blue) has an axis of rotation at the second hinge axis 7 and is attached to the other end of the coupling mechanism (annotated in yellow) at bearing bore 10, which is located "eccentrically" (i.e., off-center) to the second hinge axis 7. Thus, the coupling mechanism is attached to the first and second hinge connections and is positioned only within the space separating the first and second hinge connections.



58. Annotated Figures 1*b* and 1*c* show different perspectives of the coupling mechanism between the first and second hinge connections.



59. In view of the foregoing, I believe the specification supports and is consistent with Defendants' proposed construction.

60. I understand that Vincent proposes "a coupling mechanism between the first hinge connection and the second hinge connection" be given its plain and ordinary meaning. In my view,

the definition proposed by Defendants *is* the plain and ordinary meaning of "a coupling mechanism between the first hinge connection and the second hinge connection." Any argument by Vincent that the coupling mechanism as claimed need not connect or be only in the space between the hinges is not the plain and ordinary meaning of the term to a PHOSITA.

61. It is therefore my opinion that the term "a coupling mechanism between the first hinge connection and the second hinge connection" in claim 1 of the '666 Patent should be construed as "a component connecting and positioned within the space separating the first and second hinge connections."

c. "axially movable"

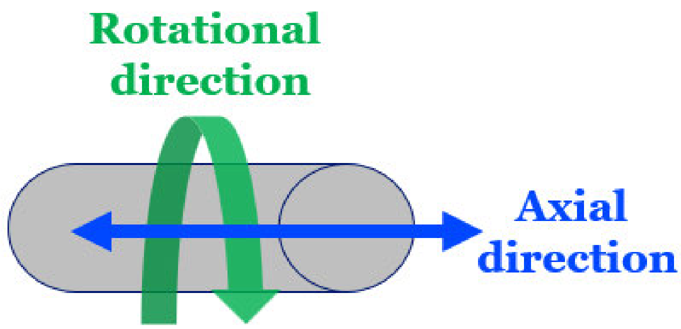
Defendants' Proposed Construction	Plaintiff's Proposed Construction
The threaded screw is able to move along the length (or axis) of the drive shaft in a straight line direction	is pushed onto the drive shaft as well as limited in its axial movement by separate guidances preferably without play[1]

62. The term "axially moveable" appears in limitation 1(f) in claim 1 of the '666 Patent. A PHOSITA would understand the plain and ordinary meaning of "axially moveable" to be "the threaded screw is able to move along the length (or axis) of the drive shaft in a straight-line direction."

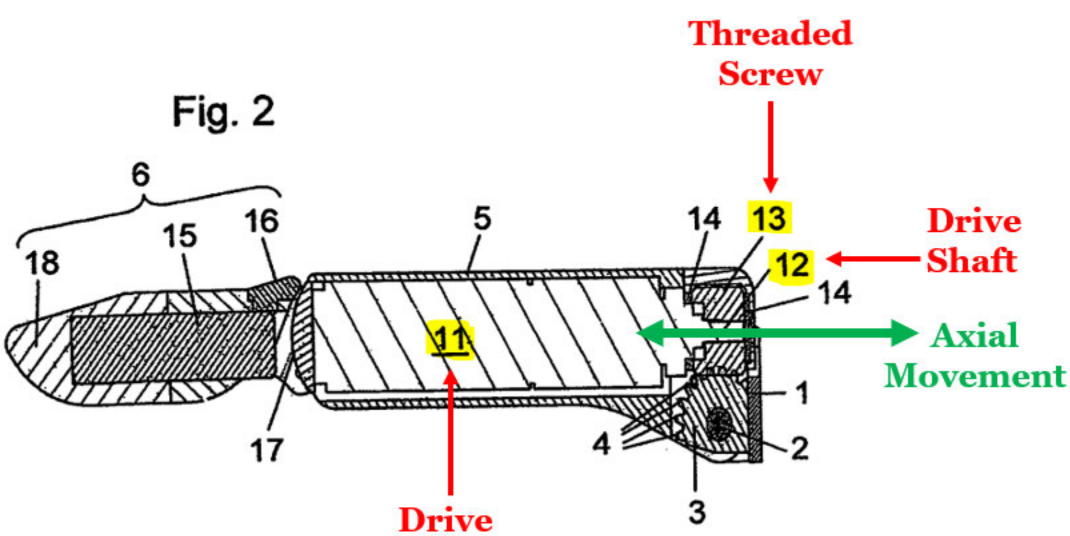
63. A PHOSITA would generally understand the term "axial" to mean along an axis or along the length of a straight line about which a body rotates. A PHOSITA would also understand axial movement to mean a change in position along the length of a straight line about which a body rotates. This movement contrasts with rotational movement, which would be understood to a PHOSITA as a change in position *around* an axis or a straight line about which a body rotates.

[1] Vincent proposes a single construction for limitation 1(f)—"the threaded screw is supported on the drive shaft form fittingly and axially movable as well as guided in axial direction by separate guidances."

The term "moveable" would be understood to a PHOSITA as able to move or *capable* of movement. Accordingly, the plain and ordinary meaning of "axially movable" means able to move along the length (or axis) of a body in a straight-line direction. This customary meaning is consistent with general dictionary definitions. *See* MC0006308, MC0006311, MC0006314, MC0006317, MC0006320, MC0006323, MC0006326, MC0006329; MC0006419, MC0006422, MC0006425, MC0006428, MC0006431.



64. In view of the foregoing and in the context of claim 1 of the '666 patent, "axially moveable" refers to the threaded screw's movement along the length of the drive shaft and relative to the drive shaft. In other words, "axially movable" means "[t]he threaded screw is able to move along the length (or axis) of the drive shaft in a straight-line direction."



65. The specification of the '666 patent does not define "axially movable" or otherwise indicate the patentee departed from the plain and ordinary meaning of "axially movable." Although portions of the specification are somewhat unclear (likely due to translational issues or errors), including to some extent the phrase "axially movable," the specification is generally consistent with the plain and ordinary meaning of the term.

66. The specification emphasizes "an essential feature" of the claimed invention is the axial movability of the threaded screw relative to the drive shaft:

> An essential feature of the invention encloses a decoupling of drive shaft and threaded screw in axial direction to the drive shaft. The threaded screw is preferably attached to the drive shaft and is in rotation direction form-fittingly coupled to the drive shaft, for instance via cogging or a matched joint. Therefore, the axial movability of the drive shaft in the threaded screw has to be assured.

Id. at 2:28-34. A PHOSITA would understand this paragraph teaches the threaded screw does *not* move in the rotational direction relative to the drive shaft (i.e., the threaded screw rotates *with* the drive shaft), but it *does* move in the axial direction relative to the drive shaft.

67. The prosecution history is also consistent with the plain and ordinary meaning of "axially movable." During prosecution, the Examiner stated the reason for the allowance was the cited prior art did not disclose a threaded screw "axially movable" on the drive shaft:

> The threaded screw "supported on the drive shaft form fittingly and axially movable as well as guided in axial direction by separate guidances" (last three lines of claim 1) in the finger element as claimed is neither taught nor fairly suggested in the prior art.

See MC0001408 at MC0001672 (3/20/2013 Notice of Allowability). The Examiner distinguished claim 1 from prior art reference US 2009/0145254 ("Hirabayashi"), which discloses "a finger joint unit for a robot hand," specifically a "worm gear type finger joint unit" with a worm screw (i.e., threaded screw) "coaxially ***fixed to a worm shaft***." Hirabayashi (MC0001111) at ¶ [0002].

68. Further, during prosecution of the German counterpart patent, I understand Vincent made various admissions that in my opinion support Defendants' proposed construction for "axially moveable." Vincent repeatedly distinguished the prior art cited by the Examiner on the basis that the threaded screw was permanently attached or mounted on the drive shaft. *See* VINCENT_004233 (Vincent noting the "threaded worm which is axially movable on the drive shaft" is a characteristic feature of the invention); VINCENT_004235 (Vincent distinguishing reference E1 because it has a "threaded screw ***firmly attached*** to a drive shaft"); VINCENT_004235 (Vincent distinguishing reference E4 because "the form in which the threaded worm is mounted with respect to the drive shaft" and "***the axially moveable bearing of the threaded worm on the drive shaft*** according to feature d) is also ***not disclosed***."); VINCENT_004235 (Vincent stating that reference E1 has "a threaded screw which is firmly attached to a drive shaft", which differs from Vincent's patent claim requiring "a threaded screw which can move axially on the drive shaft.").

69. It is my opinion that Vincent's proposed construction—"pushed onto the drive shaft and axially movable by separate guidances without play"—is nonsensical. Vincent proposes the Court construe "axially moveable" to mean "not moveable"—the exact opposite of what is claimed. In fact, the specification of the '666 patent disparages finger elements where the threaded screw is fixed (or immovable) on the drive shaft. '666 patent, 1:36-44. And Vincent's inclusion of "pushed onto the drive shaft" in its proposed construction appears to be a method of assembly and not a self-contained, finished product. Regardless of how the threaded screw is placed on the drive shaft, what is important is that *the claim requires the threaded screw be axially moveable*. Vincent's construction which completely turns the well-understood meaning of moveable on its head is indefensible and, in my opinion, should be rejected.

70. Therefore, it is my opinion that the term “axially moveable” in claim 1 of the ’666 Patent should be construed as “the threaded screw is able to move along the length (or axis) of the drive shaft in a straight line direction.”

d. “guided in the axial direction by separate guidances”

Defendants’ Proposed Construction	Plaintiff’s Proposed Construction
Indefinite or in the alternative: At least two components designed to facilitate movement of the threaded screw along the length of the drive shaft.	is pushed onto the drive shaft as well as limited in its axial movement by separate guidances preferably without play

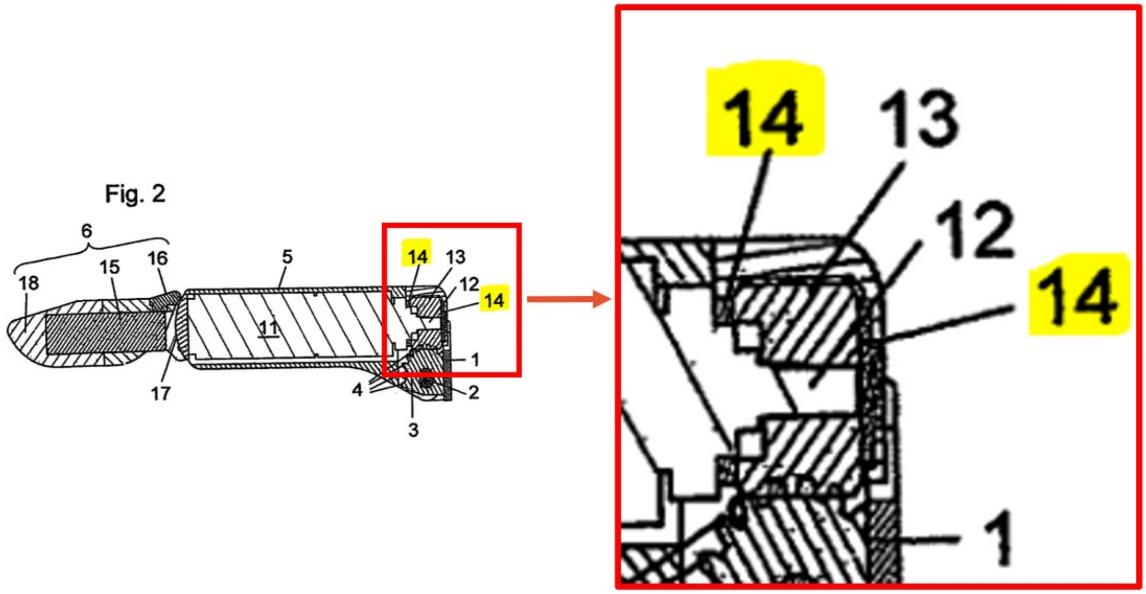
71. The term “guided in the axial direction by separate guidances” appears in limitation (f) in claim 1 of the ’666 Patent. The specification of the ’666 Patent does not expressly define “guided in the axial direction by separate guidances,” and the disclosure is so unclear as to render this term indefinite in my opinion.

72. In my opinion, the term “guided in the axial direction by separate guidances” does not have a single, plain and ordinary meaning that would be understood by a PHOSITA. The term “guidances” is not a known mechanical term in this context, nor is the phrase “guided in the axial direction” something that would be readily understood without illustration or explanation.

73. The specification of the ‘666 Patent is ambiguous and confusing in its descriptions of the mechanical arrangement between the threaded screw, the drive shaft, and the “guidances” (which are not defined), and the specification never explains or shows what it means for one component to “guide” another component in the axial direction.

74. The figures of the ’666 Patent label the “guidances” 14, but do not show these components. For example, in Fig. 2 shown below, there are two number 14s and a line assumingly pointing to what the patentee contends are “guidances,” but the component(s) it points to cannot

be seen sufficiently to discern what it is meant to be:



75. The specification also does not provide any explanation of what constitutes a "guidance." In its first reference to guidances, the '666 Patent states "***the motor does not serve via the drive shaft as axial guidance of the threaded screw, but separate guidances***. They are arranged preferably in form of ***sliding guidances*** at both front edges of the threaded screw." *Id.* at 2:35-38. I cannot discern what the patent means when it says that the drive shaft does not serve as axial guidance for the thread screw, but instead, separate guidances serve this function. This lack of clarity brings about many questions. For example: Are the guidances between the screw and the drive shaft? What are they and what are they doing? How do the "guidances" guide the threaded screw?

76. The '666 Patent in the very next paragraph states that "[i]t proved to be advantageous to combine the guidances and the threaded screws to an assembly. For instance, both guidances are realized by a stiff preferably single-part frame, in which the screw is inserted with a small axial play." *Id.* at 2:38-42. The single-part frame is not shown in the '666 Patent, and it is

unclear to me what is meant. “Small axial play” implies to me that there is a space between the guidances and the screw allowing a small amount of movement, but this still does not sufficiently reveal the nature or function of the “guidances.”

77. The ’666 Patent later states that “[t]he threaded screw is in the embodiment guided in radial direction onto the drive shaft, but is limited in its axial movability by two guidances 14 preferably without play.” *Id.* at 3:67-4:1. I understand Vincent cites this portion of the specification as support for its claim construction, but it is unclear to me what “without play” modifies. As indicated above, the ’666 Patent previously described “small axial play” when the screw was inserted in the guidances. The patent could be referring to the guidances themselves as not moving, although as discussed above, the patent refers to preferably “sliding guidances” so it is unclear what or where has “no play.” This also could refer to an unclaimed embodiment that is different than what is otherwise described, but this is similarly unclear.

78. The next sentence talks about the material of the guidances and explains “the threaded screw comprise in comparison to the materials of the guidances preferably a low sliding fiction coefficient as well as high abrasive durabilities.” *Id.* at 4:2-4. For instance, “the threaded screw is because of the expected high load of the servo drive made of brass or steel, the guidances are preferably made of dry lubricating slide bearing bushing material like a PTFE-material or a slide bearing bronze.” *Id.* at 4:4-8. This indicates to me that whatever the guidance is, it is of a material that slides more easily than the threaded screw.

79. The specification provides no further explanation regarding what the guidances are or how they relate to or impact the axial movement of the threaded screw relative to the drive shaft.

80. It is therefore my opinion that “guided in the axial direction by separate guidances” is indefinite, because a PHOSITA cannot determine with reasonable certainty what “guidances”

are or what "guided in the axial direction by separate guidances" means in the context of the '666 Patent. A PHOSITA cannot identify the bounds of the purported invention with reasonable certainty.

81. I have also been asked, in the alternative, to consider the most plausible construction that could be given to the term "guided in the axial direction by separate guidances" in the context of the '666 Patent in the event it is determined not to be indefinite. In my opinion, the meaning of "guided in the axial direction by separate guidances" that is most applicable to the subject matter disclosed in the '666 Patent is "at least two components designed to facilitate movement of the threaded screw along the length of the drive shaft." Dictionaries most commonly define "guidance" as something that guides. *See, e.g.,* MC0006416. And the most common definition of "guide" is to lead or direct, for example, along a certain path or course (i.e., guide the movement of the threaded screw in the axial direction along the drive shaft). *See, e.g.,* MC0006395, MC0006401, MC0006407, MC0006416.

82. The language of the claim itself means there must be movement of the threaded screw in the "axial direction," so the most plausible construction requires that movement is guided by the guidances. Additionally, that this construction would account for the lower sliding friction coefficient of the guidances, i.e., this facilitates the axial movement of the threaded screw.

83. Vincent's proposed construction of "limited in its axial movement by separate guidances preferably without play" makes no sense and is contradicted by the plain language of the claim for at least two reasons.

84. ***First***, Vincent's proposed construction requires the guidances limit the axial movement of the threaded screw. While I understand Vincent is relying on language in the specification for its definition, nothing in the claim language states there is limitation or restriction

of movement of the threaded screw, which is what I would expect if that was indeed the claimed invention. Claim 1 simply states the guidances guide the threaded screw. Vincent's inclusion of "limited in its axial movement" in its proposed construction narrows the scope of the claim and imports a limitation that does not exist in the claim language.

85. ***Second,*** Vincent's inclusion of "preferably without play" also adds an additional limitation that narrows the scope of the claim with no explanation. Nothing in the claim language states or implies anything about "play" and it is unclear in Vincent's proposed construction what component(s) are "without play." Is Vincent referring to the separate guidances? The guidances and the drive shaft? The guidances and the threaded screw? There are many possibilities. Therefore, in my opinion, Vincent's proposed construction is ambiguous and the claim does not provide reasonable certainty to a PHOSITA as to its scope.

* * *

I hereby declare that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I further declare that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of the Title 18 of the United States Code.

Executed on: March 10, 2024

DR. PINHAS BEN-TZVI

Pinhas Ben-Tzvi, Ph.D., P.E., FASME, SMIEEE
Professor of Mechanical Engineering
Professor of Electrical and Computer Engineering (by courtesy)
Director, VT Robotics and Mechatronics Laboratory (RMLab)
College of Engineering Faculty Fellow
Department of Mechanical Engineering, Virginia Tech
Tel/Cell: (202) 641-8011
Email: pinhas.bentzvi@gmail.com; Website: www.RMLab.org

Professional Experience

08/2022–Present: **Program Director**
Research Capacity and Competitiveness (RCC) Section
Established Program to Stimulate Competitive Research (EPSCoR)
Office of Integrative Activities (OIA), Office of the Director (OD)
National Science Foundation (NSF), Alexandria, VA

06/2020–Present: **Professor**
Department of Mechanical Engineering,
Virginia Tech, Blacksburg, VA

06/2020–Present: **Professor** (by courtesy)
Bradley Department of Electrical and Computer Engineering,
Virginia Tech, Blacksburg, VA

08/2015–05/2020: **Associate Professor**
Department of Mechanical Engineering,
Virginia Tech, Blacksburg, VA

05/2016–Present: **Associate Professor** (by courtesy)
Bradley Department of Electrical and Computer Engineering,
Virginia Tech, Blacksburg, VA

08/2014–08/2015: **Associate Professor**
Department of Mechanical & Aerospace Engineering,
George Washington University, Washington, DC

09/2008–08/2014: **Assistant Professor,** Department of Mechanical & Aerospace Engineering,
George Washington University, Washington, DC

09/2008–Present: **Founder and Director,** Robotics and Mechatronics Laboratory,
Virginia Tech, Blacksburg, VA: Aug 2015 - Present
George Washington University, Washington, DC: Sep 2008 – Aug 2015

2006 – 2008: **Lecturer,** Department of Mechanical & Industrial Engineering,
University of Toronto, Ontario, Canada

2006 – 2008: **Consultant,** Mobile Robots Division, Engineering Services Inc., Toronto, Canada
Design, Development and Integration of Mobile Robot Systems/Mechanisms

2002 – 2008: **Graduate Research Assistant,** Department of Mechanical Engineering,
University of Toronto, Ontario, Canada
Mobile robot mechanisms with hybrid mobility and manipulation (Ph.D.);
Dispensing systems for microdrops generation in medical applications (M.S.)

EXHIBIT A

2002 – 2008: **Graduate Teaching Assistant,** Department of Mechanical Engineering, University of Toronto, Ontario, Canada

2000 – 2002: **R&D Mechanical Engineer,** General Electric Medical Systems, Haifa, Israel
Conducted research on design, development, and integration of mechanisms and mechatronic/robotic systems for medical imaging systems (CT, PET, MRI)

1998 – 2000: **Research Assistant,** Technion – Israel Institute of Technology, Haifa, Israel
Developed sensors and control system for a deep drawing mechanical process

1993 – 1996: **First Sergeant,** Israeli Air Force Academy

Professional Credential

2020–present **Licensed Professional Engineer (P.E.)**, Maryland

Other Professional Affiliations/Experience:

08/2015–Present: **Core Faculty Member**
Virginia Center for Autonomous Systems (VaCAS)
Virginia Tech, Blacksburg, VA

08/2015–Present: **Affiliate Faculty Member**
Center for Bioinspired Science and Technology (BIST)
Virginia Tech, Blacksburg, VA

Education

Ph.D., **University of Toronto** 2008
Department of Mechanical Engineering (GPA 4.0/4.0)

M.Sc., University of Toronto 2004
Department of Mechanical Engineering (GPA 4.0/4.0)

B.Sc. (*Summa Cum Laude*), Technion – Israel Institute of Technology 2000
Department of Mechanical Engineering (GPA 4.0/4.0)

Practical Engineer Diploma, ORT Vocational College, Haifa, Israel 1993
Mechanical Engineering (*with Highest Honors,* GPA 4.0/4.0)

Research Expertise and Interests

My research and industrial experiences and expertise span the areas of mechanical/mechatronics design, electromechanical systems design, smart precision sensors and actuators, precision engineering design, mechanism/product design and system integration, intelligent autonomous systems and robotics, precision healthcare technologies, cyber-physical systems, machine learning and AI, human-machine interactions, industrial automation systems, feedback motion control systems, system dynamics.

Examples of research expertise include:

- Electromechanical Systems Design, Integration and Prototyping
- Linear Motion Control, Drivers, Actuators and Sensors
- Mechatronic and Robotic Systems - Design, Modeling, Simulation, Analysis, Integration
- Precision Mechanism and Machine Design, Analysis and Synthesis

- Sensing, Precision Actuation Devices and Measurement Modalities for Applications (vehicles, biomedical, industrial, etc.)
- Microprocessor-based Distributed and Modular Control Systems
- System Dynamics and Control
- Computer Aided Design/Engineering CAD/CAE
- Industrial Automation and Manufacturing Systems
- Ergonomic Industrial Design
- Intelligent Autonomous Systems
- Modular and Reconfigureable Robotic and Mechanical Systems
- Dexterous Robotic Manipulation - Tele-Operation, Autonomous Navigation/Function
- Rehabilitation and Medical Robotics
- Robotic Vision/Perception and Visual Servoing
- Bioinspired & Biomimetic Robotic Locomotion and Manipulation
- Continuum/Flexible Mechanisms and Structures
- Haptics Interfaces and Devices for Robotics Applications

Awards and Honors

Certificate of Recognition, Celebration Innovation April 2023
Virginia Tech Senior Vice President for Research & Innovation
"In recognition of being awarded and issued patents in FY 2022, and important
Step in ensuring important discoveries reach the people who will benefit most".

Faculty Inventor Spotlight May 2022
Virginia Tech Center for Technology Commercialization
https://vt.edu/link/license/faculty-inventors/pinhas-ben-tzvi.html

Fellow, American Society of Mechanical Engineers (ASME) January 2022
Fellowship is bestowed upon members who have made significant contributions to mechanical engineering with less than 3400 of ASME's approximate 140,000 members receiving the honor

Certificate of Outstanding Professional Service November 2021
ASME Journal of Mechanisms and Robotics
In recognition of your dedicated service to the *Journal of Mechanisms and Robotics* and the Mechanisms and Robotics community at large (2018-2021)

Featured Journal Publication October 2021
Guo, Y., Xu, W., Pradhan, S., Bravo, C.J., **Ben-Tzvi, P.,** "Data Driven Calibration and Control for Compact Lightweight Series Elastic Actuators for Robotic Exoskeleton Gloves", *IEEE Sensors Journal*, Vol. 21, Issue 19, pp. 21120-21130, October 2021. DOI: 10.1109/JSEN.2021.3101143
*** Selected as a featured article**

Certificate of Outstanding Professional Service as Technical Editor January 2021
IEEE/ASME Transactions on Mechatronics
In grateful appreciation for, and recognition of, your dedicated service in advancing the science and art of mechatronics as Technical Editor (2016-2020)

Certificate of Outstanding Service as Associate Editor January 2021
International Journal of Control, Automation, and Systems (IJCAS)
In Grateful Recognition of Many Years of Dedicated Service to the Control Community as an Associate Editor of IJCAS (January 1, 2011 – December 31, 2020)

Certificate of Appreciation in Outstanding Professional Service August 2019
The Design Engineering Division, ASME
In Recognition of Outstanding Service as Program Co-Chair of the 43rd Mechanisms and Robotics Conference (MR) 2019

Excellence in Teaching Award May 2019
College of Engineering, Virginia Tech
In Recognition of Extraordinary Performance in Teaching

IJCAS Academic Activity Award January 2019
International Journal of Control, Automation, and Systems (IJCAS)
"In recognition of his outstanding service and dedicated work as an editorial board member of the IJCAS and for his exceptional contributions in the advancement of the journal."

Faculty Fellow, College of Engineering April 2018
Virginia Tech
In Recognition of Extraordinary Performance in Research

Keynote Speech Award February 2018
International Conference on Mechatronics Systems and Control Engineering
"In honor of your excellent Keynote Speech and your significant contribution to the success of 2018 International Conference on Mechatronics Systems and Control Engineering (ICMSCE 2018), Amsterdam, Netherlands, Feb 21-23, 2018"

Virginia Tech Inventor of the Month August 2016
The Office of the Vice President for Research and Innovation recognizes Pinhas Ben-Tzvi as Inventor of the Month for August 2016 for his multiple inventions disclosed to Virginia Tech Intellectual Properties Inc.

IJCAS Academic Activity Award December 2013
International Journal of Control, Automation, and Systems (IJCAS)
"In recognition of his outstanding service and dedicated work as an editorial board member of the IJCAS and for his exceptional contributions in the development of the journal."

GW SEAS Outstanding Young Researcher Award April 2013
http://www.rmlab.org/honors.php
"In recognition of his demonstrated and exceptional contributions to robotics, mechatronics, mechanism design and integration, systems dynamics and control, and sensing and actuation. Developing a very strong and externally sponsored program that covers both theoretical and applied research, Prof. Ben-Tzvi has quickly established himself as one of the leading researchers in the field of robotics, mechatronics, and controls. He founded the GW Robotics & Mechatronics Research Laboratory, and used both the lab and his research to help launch the GW robotics program."

GW SEAS Outstanding Young Teacher Award April 2013
http://www.rmlab.org/honors.php
"In recognition of his dedicated pursuit of innovative curricula and teaching methods, his efforts to develop the robotics program at SEAS, and his STEM-related mentoring and outreach activities to the local community. Prof. Ben-Tzvi works tirelessly to improve and promote robotics education, in particular, and STEM-related education in general. He has developed new courses and new labs for students, initiated and spearheaded the development of a new robotics degree program option for undergraduate students, and created a variety of STEM-related educational outreach activities in robotics for the community beyond SEAS."

IEEE Senior Member (highest grade below fellow) April 2012

Winner of the Best Paper Award October 2011
for the paper entitled "MEMS-Based Microdroplet Generation with Integrated Sensing" presented at the 2011 COMSOL Conference, Boston, MA, Oct 13–15, 2011 (with Doctoral Student William Rone)

Pi Tau Sigma November 2009
Faculty Honorary Membership (elected by the students)

Featured Journal Publication March 2009
Cover Article: "Design and Analysis of a Fast Steering Mirror for Precision Laser Beams Steering"; Sensors & Transducers Journal, 5(3): 104–118 (2009)

The Robotdalen Scientific Award September 2008
Honorable Mention Recipient, Eskilstuna, Sweden

Governor General's Gold Medal Award of Canada - Finalist May 2008
Nominated by the Dept. of Mechanical Engineering at the University of Toronto among 60 graduated Ph.D. students to honor academic excellence at the doctoral level

Winner of the Best Student Paper Award October 2007
for the paper entitled "Implementation of Sensors and Control Paradigm for a Hybrid Mobile Robot Manipulator for Search and Rescue Operations" presented at the *2007 IEEE International Workshop on Robotic & Sensors Environments (ROSE 2007)*

University of Toronto Open Fellowship (four awards) 2004 – 2008
Doctorate Research, University of Toronto

University of Toronto Open Fellowship (two awards) 2002 – 2003
Masters Research, University of Toronto

Summa Cum Laude, B.Sc. in Mechanical Engineering September 2000
Technion – Israel Institute of Technology (IIT)

President's Honors List Award (five awards) 1998 – 2000
Undergraduate Studies, Faculty of Mechanical Engineering, Technion – IIT

Dean's Honors List Award (two awards) 1996 – 1998
Undergraduate Studies, Faculty of Mechanical Engineering, Technion – IIT

Award for Outstanding Academic Achievements 1998
Undergraduate Studies at the Technion – Israel Inst. of Tech., Ministry of Education, Israel

Publications

Books

[1] Kurdila, A.J., **Ben-Tzvi, P.,** Dynamics and Control of Robotic Systems. Wiley & Sons, Inc., December 2019, ISBN: 978-1-119-52483-0. (520 pages)

Peer-Reviewed Journal Publications (77 published, 0 accepted, 3 submitted/under review)

[80] Liu, Y., **Ben-Tzvi, P.,** "Development and Experiments of a Novel Quadruped Robot with a Versatile Robotic Tail," *IEEE Transactions on Robotics*, **Under review**, November 2023.

[79] Guo, Y., Xu, W., **Ben-Tzvi, P.,** " Vision-Based Human-Machine Interface for a Robotic Exoskeleton Glove Designed for Patients with Brachial Plexus Injuries", *Intelligent Service Robotics*, **Under review**, November 2023.

[78] Feng, S., Pressgrove, I., Liu, Y., **Ben-Tzvi, P.,** "Autonomous Alignment and Docking Control for a Self-reconfigurable Modular Mobile Robotic System", *Robotics Journal*, **Under review**, February 2024.

[77] Xu, W., Guo, Y., Liu, Y., **Ben-Tzvi, P.,** "Development of A Novel Compact Robotic Exoskeleton Glove with Reinforcement Learning Control", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 16, Issue 8, pp. 081016: 1-12, August 2024. DOI: https://doi.org/10.1115/1.4064283

[76] Liu, Y., **Ben-Tzvi, P.,** "How a Serpentine Tail Assists Agile Motions of Kangaroo Rats: A Dynamics and Control Approach", *Nonlinear Dynamics*, Vol. 111, pages 14783–14803, July 2023. DOI: 10.1007/s11071-023-08646-w

[75] Xu, W., Guo, Y., Bravo, C.J., **Ben-Tzvi, P.,** "Design, Control, and Experimental Evaluation of a Novel Robotic Glove System for Patients with Brachial Plexus Injuries", *IEEE Transactions on Robotics*, Vol. 39, Issue 2, pp. 1637-1652, April 2023. DOI: 10.1109/TRO.2022.3220973

[74] Han, X., Ren, H., Qi, J., **Ben-Tzvi, P.,** "Autonomous Cricothyroid Membrane Detection and Manipulation using Neural Networks and Robot Arm for First-Aid Airway Management", *Journal of Medical Devices, Transactions of the ASME*, Vol. 17, Issue 1, pp. 014502: 1-9, March 2023. DOI: https://doi.org/10.1115/1.4056505

[73] Guo, Y., Xu, W., Pradhan, S., Bravo, C.J., **Ben-Tzvi, P.,** "Personalized Voice Activated Grasping System for a Robotic Exoskeleton Glove", *Mechatronics Journal*, Vol. 83, pp. 102745:1-12, May 2022. DOI: 10.1016/j.mechatronics.2022.102745

[72] Sohal, S.S., Sebastian, B., **Ben-Tzvi, P.,** "Autonomous Docking of Hybrid-Wheeled Modular Robots With an Integrated Active Genderless Docking Mechanism", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 14, Issue 1, pp. 011010: 1-15, February 2022. DOI: doi.org/10.1115/1.4051519

[71] Njaka, T., Brizzolara, S., **Ben-Tzvi, P.,** "Design and Experimental Validation of a Novel High-Speed Omnidirectional Underwater Propulsion Mechanism", *IEEE/ASME Transactions on Mechatronics*, Vol. 26, Issue 5, pp. 2339-2349, October 2021. DOI: 10.1109/TMECH.2020.3037887

[70] Guo, Y., Xu, W., Pradhan, S., Bravo, C.J., **Ben-Tzvi, P.,** "Data Driven Calibration and Control for Compact Lightweight Series Elastic Actuators for Robotic Exoskeleton Gloves", *IEEE Sensors Journal*, Vol. 21, Issue 19, pp. 21120-21130, October 2021. DOI:10.1109/JSEN.2021.3101143 *** Selected as a featured article**

[69] Yang, J., Saab, W., Liu, Y., **Ben-Tzvi, P.,** "Reuleaux Triangle Based Two Degrees of Freedom Bipedal Robot", *Robotics Journal*, Vol. 10, Issue 4, pp. 1-15, October 2021. DOI: 10.3390/robotics10040114

[68] Liu, Y., **Ben-Tzvi, P.,** "Dynamic Modeling, Analysis, and Design Synthesis of a Reduced Complexity Quadruped with a Serpentine Robotic Tail", *Integrative and Comparative Biology*, Vol. 61, Issue 2, pp. 464-477, August 2021. DOI: 10.1093/icb/icab083

[67] Liu, Y., **Ben-Tzvi, P.,** "A New Extensible Continuum Manipulator Using Flexible Parallel

Mechanism and Rigid Motion Transmission", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 13, Issue 3, pp. 031112: 1-7, June 2021. DOI: doi.org/10.1115/1.4050097

[66] Feng, S., Sebastian, B., **Ben-Tzvi, P.,** "A Collision Avoidance Method Based on Deep Reinforcement Learning", *Robotics Journal*, Vol. 10, Issue 2, pp. 1-19, May 2021.

[65] Ren, H., Qi, J., **Ben-Tzvi, P.,** "Learning Flatness-Based Controller Using Neural Networks", *ASME Letters in Dynamic Systems and Control,* Vol. 1, Issue 2, pp. 021003: 1-6, April 2021. DOI: 10.1115/1.4046776

[64] Wang, J., Liu, Y., **Ben-Tzvi, P.,** "Robust Adaptive Input-Output Control for a Class of Modular Robotic Systems via Inverse Optimality Theory", *International Journal of Control,* Vol. 95, Issue 7, pp. 1898-1912, July 2022. DOI:10.1080/00207179.2021.1885741

[63] Liu, Y., **Ben-Tzvi, P.,** " Dynamic Modeling, Analysis, and Comparative Study of A Quadruped With Bio-Inspired Robotic Tails", *Multibody System Dynamics*, Vol. 51, Issue 2, pp. 195-219, February 2021. DOI: 10.1007/s11044-020-09764-8

[62] Vanteddu, T., **Ben-Tzvi, P.,** "Stable Grasp Control with a Robotic Exoskeleton Glove", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 12, Issue 6, pp. 061015: 1-14, December 2020.

[61] Wang, X., Ren, H., Kumar, A., **Ben-Tzvi, P.,** "Design and Analysis of a Variable Inertia Spatial Robotic Tail for Dynamic Stabilization", *Biomimetics*, Vol. 5, Issue 4, pp. 1-16, November 2020. DOI: 10.3390/biomimetics5040055

[60] Liu, Y., **Ben-Tzvi, P.**, "An Articulated Closed Kinematic Chain Planar Robotic Leg for High Speed Locomotion", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 12, Issue 4, pp. 041003: 1-15, August 2020. DOI: 10.1115/1.4045689

[59] Liu, Y., **Ben-Tzvi, P.,** "Design, Analysis and Integration of a New Two-DOF Articulated Multi-link Robotic Tail Mechanism", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 12, Issue 2, pp. 021101: 1-9, April 2020. DOI: 10.1115/1.4045842

[58] Ren, H., **Ben-Tzvi, P.,** "Advising Reinforcement Learning Towards Scaling Agents in Continuous Control Environments with Sparse Rewards", *Journal to Engineering Applications of Artificial Intelligence*, Vol. 90, pp. 103515: 1-12, April 2020. DOI: 10.1016/j.engappai.2020.103515

[57] Ren, H., **Ben-Tzvi, P.,** "Learning Inverse Kinematics and Dynamics of a Robotic Manipulator using Generative Adversarial Networks", *Robotics and Autonomous Systems*, Vol. 124, pp. 103386: 1-12, February 2020. DOI: 10.1016/j.robot.2019.103386

[56] Chauhan, R., Sebastian, B., **Ben-Tzvi, P.,** "Grasp Prediction Towards Naturalistic Exoskeleton Glove Control", *IEEE Transaction on Human-Machine Systems*, Vol. 50, Issue 1, pp. 22-31, February 2020. DOI: 10.1109/THMS.2019.2938139

[55] Refour, E., Sebastian, B., Chauhan, R., **Ben-Tzvi, P.,** "A General Purpose Robotic Hand Exoskeleton with Series Elastic Actuators", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 11, Issue 6, pp. 060902: 1-9, December 2019.

[54] Williams, A., Sebastian, B., **Ben-Tzvi, P.,** "Review and Analysis of Search, Extraction, Evacuation, and Medical Treatment Field Robots", *Journal of Intelligent and Robotic*

Systems, Vol. 96, Issue 3, pp. 401-418, December 2019.

[53] Budolak, D., **Ben-Tzvi, P.,** "Series Elastic Actuation for Improved Transparency in Time Delayed Haptic Teleoperation", *Mechatronics Journal*, Vol. 63, pp. 102278:1-8, November 2019. DOI: 10.1016/j.mechatronics.2019.102278

[52] Sebastian, B., **Ben-Tzvi, P.,** "Support Vector Machine Based Real-time Terrain Estimation for Tracked Robots", *Mechatronics Journal*, Vol. 62, pp. 102260: 1-10, October 2019.

[51] Liu, Y., Wang, J., **Ben-Tzvi, P.,** "A Cable Length Invariant Robotic Tail Using a Circular Shape Universal Joint Mechanism", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 11, Issue 5, pp. 051005: 1-14, October 2019.

[50] Kumar, P., **Ben-Tzvi, P.,** "Estimation of Wind Conditions Utilizing RC Helicopter Dynamics", *IEEE/ASME Transactions on Mechatronics*, Vol. 24, Issue 5, pp. 2293-2303, October 2019.

[49] **Ben-Tzvi, P.,** Saab, W., "A Hybrid Tracked-Wheeled Multi-Directional Mobile Robot", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 11, Issue 4, pp. 041008: 1-10, August 2019.

[48] Rone, W., Saab, W., Kumar, A., **Ben-Tzvi, P.,** "Controller Design, Analysis and Experimental Validation of a Robotic Serpentine Tail to Maneuver and Stabilize a Quadrupedal Robot", *Journal of Dynamic Systems, Measurement and Control, Transactions of the ASME*, Vol. 141, Issue 8, pp. 081002: 1-9, August 2019.

[47] Sebastian, B., **Ben-Tzvi, P.,** "Physics Based Path Planning for Autonomous Tracked Vehicle in Challenging Terrain", *Journal of Intelligent and Robotic Systems*, Vol. 95, Issue 2, pp. 511-526, August 2019.

[46] Racioppo, P., **Ben-Tzvi, P.,** "Design and Control of an Articulated Cable-Driven Modular Snake Robot", *IEEE/ASME Transactions on Mechatronics*, Vol. 24, Issue 3, pp. 893-901, June 2019.

[45] Ren, H., Kumar, A., **Ben-Tzvi, P.,** "LOSA-X: Expandable 3D Motion Tracking System", *IEEE Sensors Journal*, Vol. 19, Issue 9, pp. 3288-3295, May 2019.

[44] Saab, W., Rone, W., Kumar, A., **Ben-Tzvi, P.,** "Design and Integration of a Novel Spatial Articulated Robotic Tail", *IEEE/ASME Transactions on Mechatronics*, Vol. 24, Issue 2, pp. 434-446, April 2019.

[43] Sebastian, B., **Ben-Tzvi, P.,** "Active Disturbance Rejection Control for Handling Slip in Tracked Vehicle Locomotion", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 11, Issue 2, pp. 021003: 1-12, April 2019.

[42] Williams, A., Sebastian, B., **Ben-Tzvi, P.,** "A Robotic Head Stabilization Mechanism for Medical Transport", *Robotics Journal*, Vol. 8, Issue 1, pp. 1-16, March 2019.

[41] Saab, W., Racioppo, P., Kumar, A., **Ben-Tzvi, P.,** "Design of a Miniature Modular Inchworm Robot with an Anisotropic Friction Skin", *Robotica Journal*, Vol. 37, Issue 3, pp. 521-538, March 2019.

[40] Saab, W., Racioppo, P., **Ben-Tzvi, P.,** "A Review of Coupling Mechanism Designs for Modular Reconfigurable Robots", *Robotica Journal*, Vol. 37, Issue 2, pp. 378-403, February 2019.

[39] Rone, W., Liu, Y., **Ben-Tzvi, P.,** "Maneuvering and Stabilization Control of a Bipedal Robot with a Universal-Spatial Robotic Tail", *Bioinspiration and Biomimetics Journal*, Vol. 14, Issue 1, pp. 016014: 1-16, January 2019.

[38] Liu, Y., Kong, M., Wan, N., **Ben-Tzvi, P.,** "A Geometric Approach to Obtain the Closed-Form Forward Kinematics of H4 Parallel Robot", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 10, Issue 5, pp. 051013: 1-9, October 2018.

[37] Saab, W., Rone, W., **Ben-Tzvi, P.,** "Robotic Tails: A State-of-The-Art Review", *Robotica Journal*, Vol. 36, Issue 9, pp. 1263-1277, September 2018.

[36] Lee, J., Williams, A., **Ben-Tzvi, P.,** "Intelligent Object Grasping with Sensor Fusion for Rehabilitation and Assistive Applications", *IEEE Transactions on Neural Systems & Rehabilitation Engineering*, Vol. 26, Issue 8, pp. 1556-1565, August 2018.

[35] Rone, W., Saab, W., **Ben-Tzvi, P.,** "Design, Modeling and Integration of a Flexible Universal Spatial Robotic Tail", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 10, Issue 4, pp. 041001: 1-14, August 2018.

[34] Saab, W., Rone, W., **Ben-Tzvi, P.,** "Discrete Modular Serpentine Robotic Tail: Design, Analysis and Experimentation", *Robotica Journal*, Vol. 36, Issue 7, pp. 994-1018, July 2018.

[33] Kumar, A., **Ben-Tzvi, P.,** "Novel Wireless Sensing Platform for Experimental Mapping and Validation of Ship Air Wake", *Mechatronics Journal*, Vol. 52, pp. 58-69, June 2018.

[32] Refour, E., Sebastian, B., **Ben-Tzvi, P.,** "Two-Digit Robotic Exoskeleton Glove Mechanism: Design and Integration", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 10, Issue 2, pp. 025002: 1-9, April 2018.

[31] Yanga, Y., Ren, H., Yang, X., **Ben-Tzvi, P.,** He, Z., "Optimal Interval of Periodic Polarity Reversal for Maximizing Hydrogen Production in Microbial Electrolysis Cells", *International Journal of Hydrogen Energy*, Vol. 42, Issue 31, pp. 20260–20268, Aug. 2017.

[30] Saab, W., Rone, W., **Ben-Tzvi, P.,** "Robotic Modular Leg: Design, Analysis and Experimentation", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 9, Issue 2, pp. 024501: 1-6, April 2017.

[29] Saab, W., **Ben-Tzvi, P.,** "A Genderless Coupling Mechanism with 6-DOF Misalignment Capability for Modular Self-Reconfigurable Robots", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 8, Issue 6, pp. 061014: 1-9, December 2016.

[28] Ma, Z., **Ben-Tzvi, P.,** Danoff, J., "Hand Rehabilitation Learning System with an Exoskeleton Robotic Glove", *IEEE Transactions on Neural Systems & Rehabilitation Engineering*, Vol. 24, Issue 12, pp.1323–1332, December 2016.

[27] Zhao, H., **Ben-Tzvi, P.,** "Synchronous Position Control Strategy for Bi-Cylinder Electro-pneumatic Systems", *International Journal of Control, Automation and Systems*, Vol. 14, Issue 6, pp. 1501-1510, December 2016.

[26] Kumar, A., **Ben-Tzvi, P.,** "Spatial Object Tracking System Based on Linear Optical Sensor Arrays", *IEEE Sensors Journal*, Vol. 16, Issue 22, pp. 7933-7940, November 2016.

[25] **Ben-Tzvi, P**., Danoff, J., Ma, Z., "The Design Evolution of a Sensing and Force-Feedback Exoskeleton Robotic (SAFER) Glove for Hand Rehabilitation Application", *Journal of*

Mechanisms and Robotics, Transactions of the ASME, Vol. 8, Issue 5, pp. 051019: 1-9, October 2016.

[24] Rone, W., **Ben-Tzvi, P.,** "Dynamic Modeling and Simulation of a Yaw-Angle Quadruped Maneuvering with a Robotic Tail", *Journal of Dynamic Systems, Measurement and Control, Transactions of the ASME*, Vol. 138, Issue 8, pp. 084502: 1-7, August 2016.

[23] Kumar, A., **Ben-Tzvi, P.,** Saab, W., Snyder, M.R., "Wireless Telemetry System for Real-time Estimation of Ship Air Wake with UAVs", *Mechatronics Journal*, Vol. 36, pp. 18-26, June 2016.

[22] **Ben-Tzvi, P.,** Ma, Z., "Sensing and Force-Feedback Exoskeleton (SAFE) Robotic Glove", *IEEE Transactions on Neural Systems & Rehabilitation Engineering*, Vol. 23, Issue 6, pp. 992-1002, November 2015.

[21] Ma, Z., **Ben-Tzvi, P.,** "Design and Optimization of a Five-Finger Haptic Glove Mechanism", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 7, Issue 4, pp. 041008: 1–8, November 2015.

[20] Ma, Z., **Ben-Tzvi, P.,** "RML Glove – An Exoskeleton Glove Mechanism with Haptics Feedback", *IEEE/ASME Transactions on Mechatronics*, Vol. 20, Issue 2, pp. 641-652, April 2015.

[19] Rone, W., **Ben-Tzvi, P.,** "Mechanics Modeling of Multi-Segment Rod-Driven Continuum Robots", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 6, Issue 4, pp. 041006: 1–12, November 2014.

[18] Moubarak, P., **Ben-Tzvi, P.,** "A Tristate Rigid Reversible and Non-Back-Drivable Active Docking Mechanism for Modular Robotics", *IEEE/ASME Transactions on Mechatronics*, Vol. 19, Issue 3, pp. 840-851, June 2014.

[17] Rone, W., **Ben-Tzvi, P.,** "Continuum Robot Dynamics Utilizing the Principle of Virtual Power", *IEEE Transactions on Robotics*, Vol. 30, Issue 1, pp. 275–287, February 2014.

[16] Moubarak, P., **Ben-Tzvi, P.,** "A Globally Converging Algorithm for Adaptive Manipulation and Trajectory Following for Mobile Robots with Serial Redundant Arms", *Robotica Journal*, Vol. 31, Issue 8, pp. 1299-1312, December 2013.

[15] Rone, W., **Ben-Tzvi, P.**, "Design and FE Analysis of Integrated Sensing using Gas Compressibility for Microdroplet Generation", *Mechatronics Journal,* Vol. 23, Issue 4, pp. 397–408, June 2013.

[14] Moubarak, P., **Ben-Tzvi, P., "**On the Dual-Rod Slider Rocker Mechanism and its Applications to Tri-State Rigid Active Docking", *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 5, Issue 1, pp. 011010: 1–10, February 2013.

[13] Rone, W., **Ben-Tzvi, P.,** "Mapping, Localization and Motion Planning in Mobile Multi-Robotic Systems", *Robotica Journal*, Vol. 31, Issue 1, pp. 1-24, January 2013.

[12] Moubarak, P., **Ben-Tzvi, P.,** "Modular and Reconfigurable Mobile Robotics", *Journal of Robotics and Autonomous Systems*, Vol. 60, Issue 12, pp. 1648-1663, December 2012.

[11] Moubarak, P., **Ben-Tzvi, P.,** Zaghloul, M.E., "A Self-Calibrating Mathematical Model for the Direct Piezoelectric Effect of a new MEMS Tilt Sensor", *IEEE Sensors Journal*, Vol. 12, Issue

5, pp. 1033-1042, May 2012.

[10] **Ben-Tzvi, P.,** Bai, S., Zhou, Q., Huang, X., "Fuzzy Sliding Mode Control of Rigid-Flexible Multi-Body Systems with Bounded Inputs", *Journal of Dynamic Systems, Measurement and Control, Transactions of the ASME*, Vol. 133, Issue 6, pp. 061012: 1–8, November 2011.

[9] Bai, S., **Ben-Tzvi, P.,** Zhou, Q., Huang, X., "Variable Structure Controller Design for Linear Systems with Bounded Inputs", *International Journal of Control, Automation and Systems*, Vol. 9, Issue 2, pp. 228–236, April 2011.

[8] **Ben-Tzvi, P.,** Goldenberg, A.A., Zu, J.W., "Articulated Hybrid Mobile Robot Mechanism with Compounded Mobility and Manipulation and On-Board Wireless Sensor/Actuator Control Interfaces", *Mechatronics Journal*, Vol. 20, Issue 6, pp. 627–639, September 2010.

[7] **Ben-Tzvi, P.,** “Experimental Validation and Field Performance Metrics of a Hybrid Mobile Robot Mechanism”, *Journal of Field Robotics*, Vol. 27, Issue 3, pp. 250–267, May 2010.

[6] **Ben-Tzvi, P.**, Rone, W., "Microdroplet Generation in Gaseous and Liquid Environments", *Microsystem Technologies Journal*, Vol. 16, Issue 3, pp. 333–356, March 2010.

[5] **Ben-Tzvi, P.**, Ito, S., Goldenberg, A.A., **“**A Mobile Robot with Autonomous Climbing and Descending of Stairs”, *Robotica Journal*, Vol. 27, Issue 02, pp. 171–188, Feb. 2009.

[4] Zhou, Q., **Ben-Tzvi, P.**, Fan, D., “Design and Analysis of a Fast Steering Mirror for Precision Laser Beams Steering”, *Sensors & Transducers Journal*, Vol. 5, Issue 3, pp. 104-118, March 2009. **** Listed in the Top 25 List of Most Downloaded Articles in June 2011***

[3] Bai, S., **Ben-Tzvi, P.,** Zhou, Q., Huang, X., “A Study on Dynamic Stiffening of a Rotating Beam with a Tip Mass”, *Sensors & Transducers Journal*, Vol. 5, Issue 3, pp. 53-68, 2009.

[2] **Ben-Tzvi, P.**, Goldenberg, A.A., Zu, J.W., “Design and Analysis of a Hybrid Mobile Robot Mechanism with Compounded Locomotion and Manipulation Capability”, *Journal of Mechanical Design, Transactions of the ASME*, Vol. 130, Issue 7, pp. 1–13, July 2008.

[1] **Ben-Tzvi, P.**, Ben Mrad, R., Goldenberg, A.A., “A Conceptual Design and FE Analysis of a Piezoceramic Actuated Dispensing System for Microdrops Generation in Microarray Applications”, *Mechatronics Journal*, Vol. 17, Issue 1, pp. 1-13, February 2007.

Journal Editorials

[2] **Ben-Tzvi, P.,** Notash, L., Voglewede, P., “Special Issue: Selected Papers from IDETC 2020”, *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 13, Issue 3, pp. 030301: 1-2, June 2021. DOI: 10.1115/1.4050855

[1] Kim, C., Purwar, A., **Ben-Tzvi, P.,** “Special Issue: Selected Papers from IDETC 2019”, *Journal of Mechanisms and Robotics, Transactions of the ASME*, Vol. 12, Issue 2, pp. 1-3, April 2020. DOI: 10.1115/1.4046177

Patents (10 Issued/Allowed, 3 Non-provisional, 7 Abandoned)

[20] **Ben-Tzvi, P.,** Kamidi, V., “Articulated, Closed Kinematic Chain Planar Monopod”, U.S. Patent 11,883,959, Issued, January 30, 2024.

[19] **Ben-Tzvi, P.**, Liu, Y., Rone, W.S., Saab, W., “Articulated Multi-Link Robotic Tail Systems and

Methods", U.S. Patent Application No. 17/697,353, Published June 30, 2022.

[18] **Ben-Tzvi, P.**, Njaka, T., Brizzolara, S., "High-Speed Omnidirectional Underwater Propulsion Mechanism", U.S. Patent Application No. 17/531,007, Published December 8, 2022.

[17] **Ben-Tzvi, P.**, Refour, E., Sebastian, B., Xu, W., Guo, Y., Pradhan, S., "Robotic Exoskeleton Glove System", U.S. Patent Application No. 16/888,993, Allowed for Issuance, January 19, 2024.

[16] **Ben-Tzvi, P.**, Liu, Y., "Extensible Continuum Manipulator", U.S. PCT Patent Application No. PCT/US2021/034564, Filed May 27, 2021.

[15] **Ben-Tzvi, P.,** Kamidi, V., "Articulated Closed Kinematic Chain Planar Monopod", U.S. Patent No. 11,413,745, Issued August 16, 2022.

[14] **Ben-Tzvi, P.**, Liu, Y., Rone, W.S., Saab, W., "Articulated Multi-Link Robotic Tail Systems and Methods", U.S. Patent 11,305,420, Issued April 19, 2022.

[13] **Ben-Tzvi, P.**, Kumar, A., "Linear Optical Sensor Arrays (LOSA) Tracking System for Active Marker Based 3D Motion Tracking", U.S. Patent 10,295,651, Issued May 21, 2019.

[12] **Ben-Tzvi, P.**, Moubarak, P., "Active Docking Mechanism for Modular and Reconfigurable Robots", U.S. Patent 9,616,948, Issued April 11, 2017.

[11] **Ben-Tzvi, P.**, Goldenberg, A.A., and Zu, J.W., "Hybrid Mobile Robot", Canadian Patent No. CA2631116, Issued, September 2016.

[10] **Ben-Tzvi, P.**, Moubarak, P., "A mobile Robot with Hybrid Traction and Mobility Mechanism", U.S. Patent 9,004,200, Issued April 14, 2015.

[9] **Ben-Tzvi, P.**, "A Mobile Robot with Symbiosis of Locomotion and Manipulation", U.S. Patent 8,225,892, Issued July 24, 2012.

[8] **Ben-Tzvi, P.**, Goldenberg, A.A., and Zu, J.W., "Hybrid Mobile Robot", U.S. Patent 7,874,386, Issued January 25, 2011.

[7] **Ben-Tzvi, P.,** Yang, J., Saab, W., "Robotic Modular Leg V2 Utilizing the Reuleaux Triangle Drive Mechanism to Build Legged Mobile Robots", U.S. Provisional Patent Application No. 62/855,968, June 1, 2019. (abandoned)

[6] **Ben-Tzvi, P.,** Williams, A., Sebastian, B., Kumar, A., Saab, W., "Semi-Autonomous Victim Extraction Robot (SAVER)", U.S. Provisional Patent Application No. 62/836,915, April 22, 2019. (abandoned)

[5] **Ben-Tzvi, P.**, Kumar, A., "An Expandable 6D Motion Tracking System Using Linear Optical Sensors Arrays (LOSA-X)", U.S. Patent Application No. 16/356,568, Filed March 18, 2019. (abandoned)

[4] **Ben-Tzvi, P.**, Saab, W., "Discrete Modular Serpentine Robotic Tail Mechanism for Mobile Legged Robots", U.S. Provisional Patent Application No.62/340,140, May 23, 2016. (abandoned)

[3] **Ben-Tzvi, P.**, Saab, W., "Robotic Modular Leg Mechanism for Legged Mobile Robots", U.S. Provisional Patent Application No.62/340,136, May 23, 2016. (abandoned)

[2] **Ben-Tzvi, P.**, “A Hybrid Suspension and Tension Mechanism for Mobile Robots”, U.S. Patent Application No. 13/507,180, June 12, 2012. (abandoned)

[1] **Ben-Tzvi, P.**, “Mobile Robot with Symbiosis of Locomotion and Manipulation”, U.S. Patent Application No. 12/925,145, October 14, 2010. (abandoned)

Peer-Reviewed Conference Proceedings *(full articles with full review)* [1]

[99] Guo, Y., Xu, W., Bravo, C., **Ben-Tzvi, P.**, “Voice-Controlled Human-Machine Interface for an Assistive Exoskeleton Glove Aiding Patients with Brachial Plexus Injuries”, *Proc. of the 2024 33rd IEEE International Conference on Robot and Human Interactive Communication (ROMAN2024)*, Pasadena, CA, August 26-30, 2024, Submitted.

[98] Xu, W., Guo, Y., **Ben-Tzvi, P.,** “Robotic Exoskeleton Glove System Design and Simulation for Patients with Brachial Plexus Injuries”, *Proceedings of the 2023 ASME IDETC/CIE, 47th Mechanisms & Robotics Conference*, Boston, MA, August 20-23, 2023.

[97] Xu, W., Guo, Y., Bravo, C.J., **Ben-Tzvi, P.,** “Design, Control, and Experimental Evaluation of a Novel Robotic Glove System for Patients with Brachial Plexus Injuries”, *Proc. of the 2023 IEEE International Conference on Robotics and Automation (ICRA2023)*, London, UK**,** May 2-June 2, 2023.

[96] Xu, W., Guo, Y., Bravo, C., **Ben-Tzvi, P.**, “Development and Experimental Evaluation of a Novel Portable Haptic Robotic Exoskeleton Glove System for Patients with Brachial Plexus Injuries”, *Proceedings of the 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2022)*, Kyoto, Japan, October 23-27, 2022.

[95] Xu, W., Liu, Y., **Ben-Tzvi, P.**, “Development of a Novel Low-profile Robotic Exoskeleton Glove for Patients with Brachial Plexus Injuries”, *Proceedings of the 2022 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2022)*, Kyoto, Japan, October 23-27, 2022.

[94] Xu, W., Liu, Y., **Ben-Tzvi, P.,** “Design, Analysis, and Prototyping of a Novel Single DOF Index Finger Exoskeleton Mechanism”, *Proceedings of the 2022 ASME IDETC/CIE, 46th Mechanisms & Robotics Conference*, St. Louis, Missouri, August 14-17, 2022.

[93] Pressgrove, I., Liu, Y., **Ben-Tzvi, P.,** “Design and Implementation of a Power-Dense, Modular, and Compact Serpentine Articulated Robotic Tail”, *Proceedings of the 2022 ASME IDETC/CIE, 46th Mechanisms & Robotics Conference*, St. Louis, Missouri, Aug 14-17, 2022.

[92] Liu, Y., **Ben-Tzvi, P.**, “Systematic Development of a Novel, Dynamic, Reduced Complexity Quadruped Robot Platform for Robotic Tail Research”, *Proc. of the 2022 IEEE International Conference on Robotics and Automation (ICRA2022)*, Philadelphia, PA, pp. 4664-4670, May 23-27, 2022.

[91] Liu, Y., **Ben-Tzvi, P.,** “Feedback Control of the Locomotion of a Tailed Quadruped Robot”,

[1] Although in some areas conference papers are considered non-peer reviewed publications, in my field all conference papers are peer reviewed. For example, **ICRA and IROS** are the largest robotics conferences organized by IEEE society. The acceptance rate for ICRA in 2022 was **43.1%, 38.7%** in 2006, **44.3%** in 2007, **43%** in 2009, **41.0%** in 2010, **40.25%** in 2012, **38.5%** in 2013, **43.1%** in 2022. The acceptance rate for IROS in 2022 was **48%**, and in 2017 and 2018 **45%**. The journals IEEE Transactions on Robotics, IEEE/ASME Transactions on Mechatronics, IEEE Transactions on Neural Systems & Rehabilitation Engineering, IEEE Sensors Journal, Journal of Field Robotics, ASME Journal of Mechanical Design, and ASME Journal of Mechanisms and Robotics have the highest impact factors in my discipline (Robotics/ Mechatronics/ Design).

Proceedings of the 2021 ASME IDETC/CIE, 45th Mechanisms & Robotics Conference, Virtual, Online, Aug. 17-20, 2021.

[90] Guo, Y., Xu, W., Pradhan, S., Bravo, C.J., **Ben-Tzvi, P.,** "Integrated and Configurable Voice Activation and Speaker Verification System for a Robotic Exoskeleton Glove", *Proceedings of the 2020 ASME IDETC/CIE, 44th Mechanisms & Robotics Conference*, St. Louis, MO, Aug. 16-19, 2020.

[89] Xu, W., Pradhan, S., Guo, Y., Bravo, C.J., **Ben-Tzvi, P.,** "A Novel Design of a Robotic Glove System for Patients with Brachial Plexus Injuries", *Proceedings of the 2020 ASME IDETC/CIE, 44th Mechanisms & Robotics Conference*, St. Louis, MO, Aug. 16-19, 2020.

[88] Han, X., Ren, H., **Ben-Tzvi, P.,** "Autonomous Cricothyroid Membrane Detection Using Neural Networks for First-Aid Surgical Airway Management", *Proceedings of the 2020 ASME IDETC/CIE, 44th Mechanisms & Robotics Conference*, St. Louis, MO, Aug. 16-19, 2020.

[87] Liu, Y., **Ben-Tzvi, P.,** "A New Extensible Continuum Manipulator Using Flexible Parallel Mechanism and Rigid Motion Transmission", *Proceedings of the 2020 ASME IDETC/CIE, 44th Mechanisms & Robotics Conference*, St. Louis, MO, Aug. 16-19, 2020.

[86] Sohal, S.S., **Ben-Tzvi, P.,** "Sensor Based Target Tracking with Application to Autonomous Docking and Self-Reconfigurability", *Proceedings of the 2020 ASME IDETC/CIE, 44th Mechanisms & Robotics Conference*, St. Louis, MO, Aug. 16-19, 2020.

[85] Liu, Y., **Ben-Tzvi, P.,** "Maneuvering and Stabilization of Reduced Complexity Legged Robots Using Bioinspired Robotic Tails", *2019 Do Good Robotics Symposium (DGRS),* University of Maryland, College Park, MD, Oct. 3-4, 2019.

[84] Chauhan, R., **Ben-Tzvi, P.,** "A Series Elastic Actuator Design and Control in a Linkage Based Hand Exoskeleton", *Proceedings of the ASME 2019 Dynamic Systems and Control Conf. (DSCC 2019),* Park City, Utah, Oct. 8-11, 2019.

[83] Ren, H., Qi, J., **Ben-Tzvi, P.,** "Learning Flatness-Based Controller Using Neural Networks", *Proceedings of the ASME 2019 Dynamic Systems and Control Conf. (DSCC 2019),* Park City, Utah, Oct. 8-11, 2019.

[82] Liu, Y., **Ben-Tzvi, P.,** "A New Approach to Model the Constant Curvature Continuum Robot Dynamics", *Proceedings of the ASME 2019 Dynamic Systems and Control Conf. (DSCC 2019),* Park City, Utah, Oct. 8-11, 2019.

[81] Yang, J., Saab, W., **Ben-Tzvi, P.**, "A Two-DOF Bipedal Robot Utilizing the Reuleaux Triangle Drive Mechanism", *Proceedings of the 2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2019)*, Macau, China, pp. 4660-4665, Nov. 3–8, 2019.

[80] Sebastian, B., Ren, H., **Ben-Tzvi, P.**, "Neural Network Based Heterogeneous Sensor Fusion for Robot Motion Planning", *Proceedings of the 2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2019)*, Macau, China, pp. 2899-2904, Nov. 3–8, 2019.

[79] Budolak, D., Chauhan, R., **Ben-Tzvi, P.,** "Semi-Autonomous Teleoperation, Guidance, and Obstacle Avoidance with Path Adherence", *Proceedings of the 2019 ASME IDETC/CIE, 43rd Mechanisms & Robotics Conference*, Anaheim, CA, Aug. 18-21, 2019.

[78] Sohal, S.S., **Ben-Tzvi, P.,** "Image-Based Motion Analysis for Self-Reconfigurable Mobile Robots with Integrated Docking", *Proceedings of the 2019 ASME IDETC/CIE, 43rd*

EXHIBIT A

Mechanisms & Robotics Conference, Anaheim, CA, Aug. 18-21, 2019.

[77] Njaka, T., Brizzolara, S., **Ben-Tzvi, P.,** "Design and Simulation of a Novel High-Speed Omnidirectional Fully-Actuated Underwater Propulsion Mechanism", *Proceedings of the 2019 ASME IDETC/CIE, 43rd Mechanisms & Robotics Conference*, Anaheim, CA, Aug. 18-21, 2019.

[76] Feng, S., Ren, H., Wang, X., **Ben-Tzvi, P.,** "Mobile Robot Obstacle Avoidance Based on Deep Reinforcement Learning", *Proceedings of the 2019 ASME IDETC/CIE, 43rd Mechanisms & Robotics Conference*, Anaheim, CA, Aug. 18-21, 2019.

[75] Liu, Y., **Ben-Tzvi, P.,** "Design, Analysis, and Optimization of a New Two-DOF Articulated Multi-link Robotic Tail", *Proceedings of the 2019 ASME IDETC/CIE, 43rd Mechanisms & Robotics Conference*, Anaheim, CA, Aug. 18-21, 2019.

[74] Kamidi, V., Williams, A., **Ben-Tzvi, P.**, "A Framework for Modeling Closed Kinematic Chains with a Focus on Legged Robots", *Proceedings of the 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2018)*, Madrid, Spain, pp. 2733-2738, Oct. 1–5, 2018.

[73] Saab, W., Yang, J., **Ben-Tzvi, P.**, "Modeling and Control of an Articulated Tail for Maneuvering a Reduced Degree of Freedom Legged Robot", *Proceedings of the 2018 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2018)*, Madrid, Spain, pp. 2695-2700, Oct. 1–5, 2018.

[72] Vanteddu, T., Sebastian, B., **Ben-Tzvi, P.**, "Design Optimization of RML Glove for Improved Grasp Performance", *Proceedings of the ASME 2018 Dynamic Systems and Control Conf. (DSCC 2018),* Atlanta, GA, Sep. 30 – Oct. 3, 2018.

[71] Ren, H., Kumar, A., Wang, X., **Ben-Tzvi, P.**, "Parallel Deep Learning Ensembles for Human Pose Estimation", *Proceedings of the ASME 2018 Dynamic Systems and Control Conf. (DSCC 2018),* Atlanta, GA, Sep. 30 – Oct. 3, 2018.

[70] Wang, J., Kamidi, V., **Ben-Tzvi, P.**, "A Multibody Toolbox for Hybrid Dynamic System Modeling Based on Nonholonomic Symbolic Formalism", *Proceedings of the ASME 2018 Dynamic Systems and Control Conf. (DSCC 2018),* Atlanta, GA, Sep. 30 – Oct. 3, 2018.

[69] Chauhan, R., **Ben-Tzvi, P.**, "Latent Variable Grasp Prediction for Exoskeletal Glove Control", *Proceedings of the ASME 2018 Dynamic Systems and Control Conf. (DSCC 2018),* Atlanta, GA, Sep. 30 – Oct. 3, 2018.

[68] Refour, E., Sebastian, B., **Ben-Tzvi, P.,** "Design and Implementation of an Exoskeleton Glove for Infant Medical Rehabilitation", *Proceedings of the 2018 ASME IDETC/CIE, 42nd Mechanisms & Robotics Conference*, Quebec City, Canada, Aug. 26-29, 2018.

[67] Sohal, S.S., Saab, W., **Ben-Tzvi, P.,** "Improved Alignment Estimation for Autonomous Docking of Mobile robots", *Proceedings of the 2018 ASME IDETC/CIE, 42nd Mechanisms & Robotics Conference*, Quebec City, Canada, Aug. 26-29, 2018.

[66] Liu, Y., **Ben-Tzvi, P.,** "Dynamic Modeling of a Quadruped with a Robotic Tail Using Virtual Work Principle", *Proceedings of the 2018 ASME IDETC/CIE, 42nd Mechanisms & Robotics Conference*, Quebec City, Canada, Aug. 26-29, 2018.

[65] Sebastian, B., Williams, A., **Ben-Tzvi, P.,** "Gaussian Kernel Controller for Path Tracking in

EXHIBIT A

Mobile Robots", *Proceedings of the 2018 ASME IDETC/CIE, 42nd Mechanisms & Robotics Conference*, Quebec City, Canada, Aug. 26-29, 2018.

[64] Lee, J., **Ben-Tzvi, P.**, "Design of a Wearable 3-DOF Forearm Exoskeleton for Rehabilitation and Assistive Purposes", *Proceedings of the 2017 ASME International Mechanical Engineering Congress and Exposition (IMECE 2017)*, Tampa, Florida, Nov. 3–9, 2017.

[63] Sebastian, B., Williams, A., **Ben-Tzvi, P.**, "Control of a Head Stabilization System for Use in Robotic Disaster Response", *Proceedings of the 2017 ASME International Mechanical Engineering Congress and Exposition (IMECE 2017)*, Tampa, Florida, Nov. 3–9, 2017.

[62] Rone, W., **Ben-Tzvi, P.**, "Design, Modeling and Optimization of the Universal-Spatial Robotic Tail", *Proceedings of the 2017 ASME International Mechanical Engineering Congress and Exposition (IMECE 2017)*, Tampa, Florida, Nov. 3–9, 2017.

[61] Kumar, A., **Ben-Tzvi, P.**, "An Inertial Sensor to Measure Wind Turbulence with RC Helicopters", *Proceedings of the ASME 2017 Dynamic Systems and Control Conf. (DSCC 2017),* Tysons Corner, VA, Oct 11-13, 2017.

[60] Saab, W., **Ben-Tzvi, P.**, "Maneuverability and Heading Control of a Quadruped Robot Utilizing Tail Dynamics", *Proceedings of the ASME 2017 Dynamic Systems and Control Conf. (DSCC 2017),* Tysons Corner, VA, Oct 11-13, 2017.

[59] Kumar, A., Ren, H., **Ben-Tzvi, P.**, "Obstacle Identification for Vision Assisted Control Architecture of a Hybrid Mechanism Mobile Robot", *Proceedings of the ASME 2017 Dynamic Systems and Control Conf. (DSCC 2017),* Tysons Corner, VA, Oct 11-13, 2017.

[58] Kamidi, V., Saab, W., **Ben-Tzvi, P.**, "Design And Analysis of a Novel Planar Robotic Leg For High-Speed Locomotion", *Proceedings of the 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2017)*, Vancouver, Canada, pp. 6343–6348, Sep. 24–28, 2017.

[57] Rone, W., **Ben-Tzvi, P.**, "Maneuvering and Stabilizing Control of a Quadrupedal Robot using a Serpentine Robotic Tail", *2017 IEEE Conference on Control Technology and Applications*, Kohala Coast, Hawai'i, pp. 1763–1768, Aug. 27–30, 2017.

[56] Racioppo, P., **Ben-Tzvi, P.**, "Modeling and Control of a Cable Driven Modular Snake Robot", *2017 IEEE Conference on Control Technology and Applications*, Kohala Coast, Hawai'i, pp. 468–473, Aug. 27–30, 2017.

[55] Williams, A., Saab, W., **Ben-Tzvi, P.,** "Analysis of Differential Mechanisms for a Robotic Head Stabilization System", *Proceedings of the 2017 ASME IDETC/CIE, 41st Mechanisms & Robotics Conference*, Cleveland, Ohio, Aug. 6-9, 2017.

[54] Refour, E., Sebastian, B., **Ben-Tzvi, P.,** "Design and Integration of a Two-Digit Exoskeleton Glove", *Proceedings of the 2017 ASME IDETC/CIE, 41st Mechanisms & Robotics Conference*, Cleveland, Ohio, Aug. 6-9, 2017.

[53] Racioppo, P., Saab, W., **Ben-Tzvi, P.,** "Design and Analysis of Reduced Degree-of-Freedom Modular Snake Robot", *Proceedings of the 2017 ASME IDETC/CIE, 41st Mechanisms & Robotics Conference*, Cleveland, Ohio, Aug. 6-9, 2017.

[52] Kumar, P., Saab, W., **Ben-Tzvi, P.,** "Design of a Multi-Directional Hybrid-Locomotion Modular Robot with Feedforward Stability Control", *Proceedings of the 2017 ASME*

IDETC/CIE, 41st Mechanisms & Robotics Conference, Cleveland, Ohio, Aug. 6-9, 2017.

[51] Burns, C., Francom, M., Repisky, P., Kinney, A., Medina, B., Tello, E., **Ben-Tzvi, P.,** "Development of Autonomous Robotic Cataract Surgery Device", *Proceedings of the 2016 ASME IDETC/CIE, 40th Mechanisms & Robotics Conference*, Charlotte, North Carolina, Aug. 21-24, 2016.

[50] Saab, W., **Ben-Tzvi, P.,** "Design and Analysis of a Miniature Modular Inchworm Robot", *Proceedings of the 2016 ASME IDETC/CIE, 40th Mechanisms & Robotics Conference*, Charlotte, North Carolina, Aug. 21-24, 2016.

[49] Saab, W., **Ben-Tzvi, P.,** "Design and Analysis of a Discrete Modular Robotic Tail for Improved Performance of Mobile Robots", *Proceedings of the 2016 ASME IDETC/CIE, 40th Mechanisms & Robotics Conference*, Charlotte, North Carolina, Aug. 21-24, 2016.

[48] Saab, W., **Ben-Tzvi, P.,** "Design and Analysis of a Robotic Modular Leg Mechanism", *Proceedings of the 2016 ASME IDETC/CIE, 40th Mechanisms & Robotics Conference*, Charlotte, North Carolina, Aug. 21-24, 2016.

[47] Kumar, A., **Ben-Tzvi, P.**, "Extraction of Impact of Wind Turbulence on RC Helicopters using Machine Learning", *Proceedings of the 2016 ASME IDETC/CIE, 40th Mechanisms & Robotics Conference*, Charlotte, North Carolina, Aug. 21-24, 2016.

[46] Saab, W., **Ben-Tzvi, P.,** "Development of a Novel Coupling Mechanism for Modular Self-Reconfigurable Mobile Robots", *Proceedings of the 2015 ASME IDETC/CIE, 39th Mechanisms & Robotics Conference,* Boston, MA, Aug. 2–5, 2015.

[45] Rone, W., **Ben-Tzvi, P.,** "Static Modeling of a Multi-Segment Serpentine Robotic Tail", *Proceedings of the 2015 ASME IDETC/CIE, 39th Mechanisms & Robotics Conference,* Boston, MA, Aug. 2–5, 2015.

[44] Ma, Z., **Ben-Tzvi, P.,** Danoff, J., "Sensing and Force-Feedback Exoskeleton Robotic (SAFER) Glove Mechanism for Hand Rehabilitation", *Proceedings of the 2015 ASME IDETC/CIE, 39th Mechanisms & Robotics Conference,* Boston, MA, Aug. 2–5, 2015.

[43] Kumar, A., **Ben-Tzvi, P.,** Snyder, M.R., "UAV-based Wireless Telemetry System for the Estimation of Ship Air Wake Patterns", *Proc. of the 2015 ASME IDETC/CIE, 2015 ASME/IEEE International Conference on Mechatronic and Embedded Systems and Applications,* Boston, MA, Aug. 2–5, 2015.

[42] Ma, Z., **Ben-Tzvi, P.,** "Modeling Human Hand and Sensing Hand Motions with the Five-Fingered Haptic Glove Mechanism", *Proc. of the 2014 ASME Int'l Design Engineering Technical Conferences & Computers and Information in Engineering Conf. (IDETC/CIE 2014), 38th Mechanisms & Robotics Conference,* Buffalo, NY, Aug. 17–20, 2014.

[41] Rone, W., **Ben-Tzvi, P.,** "Continuum Robotic Tail Loading Analysis for Mobile Robot Stabilization and Maneuvering", *Proceedings of the 2014 ASME Int'l Design Engineering Technical Conferences & Computers and Information in Engineering Conf. (IDETC/CIE 2014), 38th Mechanisms & Robotics Conference,* Buffalo, NY, Aug. 17–20, 2014.

[40] Snyder, M.R., Kumar, A., **Ben-Tzvi, P.,** "Off Ship Measurement of Ship Air Wakes Using Instrumented Unmanned Aerial Vehicles", *32nd AIAA Applied Aerodynamics Conference, AIAA Aviation and Aeronautics Forum and Exposition 2014*, AIAA Paper 2014-3100, Atlanta, GA, 16-20 June 2014.

[39] Rone, W., **Ben-Tzvi, P.,** "Multi-Segment Continuum Robot Shape Estimation Using Passive Cable Displacements", *Proceedings of the 2013 IEEE International Symposium on Robotic and Sensors Environments (ROSE 2013)*, Washington, DC, pp. 37–42, Oct. 21-23, 2013.

[38] Ma, Z., **Ben-Tzvi, P.,** "Tendon Transmission Efficiency of A Two-finger Haptic Glove", *Proceedings of the 2013 IEEE International Symposium on Robotic and Sensors Environments (ROSE 2013)*, Washington, DC, pp. 13–18, Oct. 21-23, 2013.

[37] Kumar, A., **Ben-Tzvi, P.,** Snyder, M.R., Saab, W., "Instrumentation System for Ship Airwake Measurement", *Proceedings of the 2013 IEEE Int'l Symposium on Robotic and Sensors Environments (ROSE 2013)*, Washington, DC, pp. 118–123, Oct. 21-23, 2013.

[36] Moubarak, P., Alvarez, E., **Ben-Tzvi, P.**, "Reconfiguring a Modular Robot into a Humanoid Formation: A Multi-Body Dynamic Perspective on Motion Scheduling for Modules and their Assemblies", *Proc. of the 2013 IEEE International Conference on Automation Science and Engineering (CASE2013)*, Madison, Wisconsin, pp. 687–692, Aug. 17-21, 2013.

[35] Moubarak, P., **Ben-Tzvi, P.,** "Globally Converging MIMO Optimal Controller for Adaptive Manipulation of Mobile Robots with Redundant Arms", *Proceedings of the 2013 American Control Conference*, Washington, DC, pp. 5729–5734, June 17–19, 2013.

[34] Moubarak, P., **Ben-Tzvi, P.**, Ma, Z., Alvarez, E., "An Active Coupling Mechanism with Three Modes of Operation for Modular Mobile Robotics", *Proc. of the 2013 IEEE International Conference on Robotics and Automation (ICRA2013)*, Karlsruhe, Germany, pp. 5469–5474, May 6-10, 2013.

[33] Snyder, M.R., Kumar, A., **Ben-Tzvi, P.,** Kang, H.S., "Validation of Computational Ship Air Wakes for a Naval Research Vessel", *American Institute of Aeronautics and Astronautics (AIAA) 51st Aerospace Sciences Meeting*, AIAA Paper 2013-0959, Grapevine, Texas, January 7-10, 2013. DOI: 10.2514/6.2013-959

[32] Rone, W., **Ben-Tzvi, P.,** "Continuum Manipulator Statics Based on the Principle of Virtual Work", *Proceedings of the 2012 ASME International Mechanical Engineering Congress and Exposition (IMECE 2012),* Houston, TX, pp. 321-328, November 9–15, 2012.

[31] Moubarak, P., **Ben-Tzvi, P.,** Ma, Z., Alvarez, E., "Kinematic Synthesis and Dynamic Analysis of the Dual-Rod Slider Crank Mechanism: An Application to Modular Robotics", *Proceedings of the 2012 ASME IDETC/CIE, 36th Mechanisms & Robotics Conference,* Chicago, IL, pp. 1073-1078, Aug. 12–15, 2012.

[30] Ma, Z., **Ben-Tzvi, P.,** "An Admittance Glove Mechanism for Controlling a Mobile Robot", *Proceedings of the 2012 ASME IDETC/CIE, 36th Mechanisms & Robotics Conference,* Chicago, IL, pp. 1109-1114, Aug. 12–15, 2012.

[29] Moubarak, P., Barsky, D., **Ben-Tzvi, P.,** Zaghloul, M., "A Self-Calibrating Temperature Independent Model of a Bi-Axial Piezoelectric MEMS Tilt Sensor," *Proceedings of SPIE - Defense, Security, and Sensing, Micro- and Nanotechnology Sensors, Systems, and Applications IV Conference*, Vol. 8373, 83732L-1, Baltimore, MD, April 23-27, 2012.

[28] Gilman, C., **Ben-Tzvi, P.,** Yessin, G., Danoff, J., "A Robotic Wrist Exoskeleton Device for Augmenting Wrist Movement and Grip Function in Debilitated Patients", *Proceedings of the 2011 ASME International Mechanical Engineering Congress and Exposition (IMECE 2011),* Denver, CO, pp. 1041-1050, November 11–17, 2011.

[27] Ma, Z., **Ben-Tzvi, P.,** "An Admittance Type Haptic Device: RML Glove", *Proceedings of the 2011 ASME International Mechanical Engineering Congress and Exposition (IMECE 2011),* Denver, CO, pp. 1219-1226, November 11–17, 2011.

[26] Gilani, O., **Ben-Tzvi, P.,** "Bioinspired Jumping Mobility Concepts for Rough Terrain Mobile Robots", *Proceedings of the 2011 ASME International Mechanical Engineering Congress and Exposition (IMECE 2011),* Denver, CO, pp. 207-214, November 11–17, 2011.

[25] Gilani, O., **Ben-Tzvi, P.**, "The Application of Bipinspired Jumping Locomotion Principles to Mobile Robots: Modeling and Analysis", *Proceedings of the 2011 ASME Annual Dynamic Systems and Control Conf. (DSCC 2011),* Arlington, VA, pp. 427-434, Oct 31–Nov 2, 2011.

[24] Rone, W., **Ben-Tzvi, P.,** "MEMS-Based Microdroplet Generation with Integrated Sensing", *COMSOL Conference*, Boston, MA, October 13-15, 2011.
****** Winner of the Best Paper Award ******

[23] Moubarak, P., **Ben-Tzvi, P.,** "Design and Analysis of a New Piezoelectric MEMS Tilt Sensor*", Proceedings of the 2011 IEEE International Symposium on Robotic and Sensors Environments (ROSE 2011)*, Montreal, Quebec, Canada, pp. 83–88, Sep. 17-18, 2011.

[22] Moubarak, P., **Ben-Tzvi, P.,** "Adaptive Manipulation of a Hybrid Mechanism Mobile Robot*", Proceedings of the 2011 IEEE International Symposium on Robotic and Sensors Environments (ROSE 2011)*, Montreal, Quebec, Canada, pp. 113–118, Sep. 17-18, 2011.

[21] Rone, W., **Ben-Tzvi, P.**, "Finite Element Modeling of a Microdroplet Generator with Integrated Sensing", *Proceedings of the 2011 ASME International Design Engineering Technical Conferences & Computers and Information in Engineering Conference (IDETC/CIE 2011), 2011 ASME/IEEE International Conference on Mechatronic and Embedded Systems and Applications (MESA2011),* Washington, DC, Aug. 28–31, 2011.

[20] Moubarak, P., **Ben-Tzvi, P.,** Ma, Z., Dumas, M., "A Mobile Robotic Platform for Autonomous Navigation and Dexterous Manipulation in Unstructured Environments", *Proceedings of the 2010 ASME International Mechanical Engineering Congress and Exposition (IMECE 2010),* Vancouver, British Columbia, Canada, November 12–18, 2010.

[19] **Ben-Tzvi, P.,** Zhuk, M., "Real-time Dynamic Modeling and Virtual Prototype Simulation of Mechanical systems", *Proceedings of the 2010 ASME International Mechanical Engineering Congress and Exposition (IMECE 2010),* Vancouver, British Columbia, Canada, November 12–18, 2010.

[18] Charifa, S., **Ben-Tzvi, P.,** "Using Backpropagation Neural Network in Object Recognition for Hybrid Mechanism Mobile Robot", *Proceedings of the 2010 ASME International Mechanical Engineering Congress and Exposition (IMECE 2010),* Vancouver, British Columbia, Canada, November 12–18, 2010.

[17] Moubarak, P., **Ben-Tzvi, P.,** and Ma, Z., "A Generic Configuration of a Compact Dexterous and Self-Contained End-Effector for Mobile Robotic Platforms*", Proceedings of the 2010 IEEE International Workshop on Robotic and Sensors Environments (ROSE 2010)*, Phoenix, Arizona, pp. 116–121, October 15-16, 2010.

[16] **Ben-Tzvi, P.,** Xu, X., "An Embedded Feature-Based Stereo Vision System for Autonomous Mobile Robots*", Proceedings of the 2010 IEEE International Workshop on Robotic and Sensors Environments (ROSE 2010)*, Phoenix, Arizona, pp. 176–181, October 15-16, 2010.

[15] **Ben-Tzvi, P.,** Charifa, S., Shick, M., "Extraction of 3D Images Using Pitch-Actuated 2D Laser Range Finder for Robotic Vision", *Proceedings of the 2010 IEEE International Workshop on Robotic and Sensors Environments (ROSE 2010)*, Phoenix, Arizona, pp. 140–145, October 15-16, 2010.

[14] Zhou, Q., **Ben-Tzvi, P.,** Iqbal, A., Fan, D., "Design, Analysis and Optimization of Magnetic Microactuators", *Proceedings of the 2009 ASME Int'l Mechanical Engineering Congress and Exposition (IMECE 2009),* Lake Buena Vista, Florida, pp. 503-512, Nov. 13-19, 2009.

[13] Bai, S., **Ben-Tzvi, P.,** Zhou, Q., Huang, X., "Fuzzy Sliding Mode Control of Flexible Spacecraft with Input Saturation", *Proceedings of the 2009 ASME International Mechanical Engineering Congress and Exposition (IMECE 2009),* Lake Buena Vista, Florida, pp. 1055-1061, November 13-19, 2009.

[12] **Ben-Tzvi, P.**, "Experimental Validation of a Hybrid Mobile Robot Mechanism with Interchangeable Locomotion and Manipulation", *Proceedings of the 2009 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2009)*, St. Louis, Missouri, pp. 420–421, October 11–15, 2009.

[11] **Ben-Tzvi, P.**, "Wireless Modular Control Hardware Architecture for Hybrid Mechanism Mobile Robot", *Proceedings of the 2009 ASME International Design Engineering Technical Conferences & Computers and Information in Engineering Conf. (IDETC/CIE 2009), 33rd Mechanisms & Robotics Conference,* San Diego, CA, pp. 675–680, Aug. 30–Sep. 2, 2009.

[10] Zhao, H., **Ben-Tzvi, P.**, Tingqi Lin, T., Goldenberg, A.A., "Two–layer Sliding Mode Control of Pneumatic Position Synchro System with Feedback Linearization Based on Friction Compensation", *Proceedings of the 2008 IEEE International Workshop on Robotic and Sensors Environments (ROSE 2008)*, Ottawa, ON, Canada, pp. 41–45, Oct 17–18, 2008.

[9] Zhou, Q., **Ben-Tzvi, P.**, Fan, D., Goldenberg, A.A., "Design of Fast Steering Mirror Systems for Precision Laser Beams Steering", *Proceedings of the 2008 IEEE International Workshop on Robotic and Sensors Environments (ROSE 2008)*, Ottawa, Ontario, Canada, pp. 144–149, October 17–18, 2008.

[8] Bai, S., **Ben-Tzvi, P**., Zhou, Q., Huang, X., "Dynamic Modeling of a Rotating Beam Having a Tip Mass", *Proceedings of the 2008 IEEE International Workshop on Robotic and Sensors Environments (ROSE 2008)*, Ottawa, Ontario, Canada, pp. 52–57, October 17–18, 2008.

[7] **Ben-Tzvi, P.**, Goldenberg, A.A., and Zu, J.W., "Design, Simulations and Optimization of a Tracked Mobile Robot Manipulator with Hybrid Locomotion and Manipulation Capabilities", *Proceedings of the 2008 IEEE International Conference on Robotics and Automation (ICRA2008)*, Pasadena, California, pp. 2307–2312, May 19–23, 2008.

[6] **Ben-Tzvi, P.**, Goldenberg, A.A., "Mobile Robots for Hazardous Environments: New Technology for Mobility", *ANS 2nd Int. Joint Topical Meeting on Emergency Preparedness & Response and Robotic & Remote Systems (12th Robotics & Remote Systems for Hazardous Environments)*, Albuquerque, NM, Mar 9–12, 2008.

[5] Raoufi, C., **Ben-Tzvi, P.**, Goldenberg, A.A., and Kucharczyk, W., "A MR-Compatible Tele-Robotic System for MRI-Guided Intervention: System Overview and Mechanical Design", *Proceedings of the 2007 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2007)*, San Diego, California, pp. 1975–1800, October 29 – Nov 2, 2007.

[4] **Ben-Tzvi, P.**, Goldenberg, A.A., and Zu, J.W., "Implementation of Sensors and Control Paradigm for a Hybrid Mobile Robot Manipulator for Search and Rescue Operations", *Proceedings of the 2007 IEEE International Workshop on Robotic and Sensors Environments (ROSE 2007)*, Ottawa, Ontario, Canada, pp. 92–97, October 12–13, 2007. ****** Winner of the Best Student Paper Award ******

[3] **Ben-Tzvi, P.**, Ito, S., and Goldenberg, A.A., "Autonomous Stair Climbing with Reconfigurable Tracked Mobile Robot", *Proceedings of the 2007 IEEE International Workshop on Robotic and Sensors Environments (ROSE 2007)*, Ottawa, Canada, pp. 104–109, October 12–13, 2007.

[2] **Ben-Tzvi, P.**, Raoufi, C., Goldenberg, A.A., Zu, J.W., "Virtual Prototype Development and Simulations of a Tracked Hybrid Mobile Robot", *Proceedings of MSC Software 2007 Virtual Product Development Conference*, Detroit, Michigan, October 10–12, 2007.

[1] **Ben-Tzvi, P.**, Goldenberg, A.A., Zu, J.W., "A Novel Control Architecture and Design of Hybrid Locomotion and Manipulation Tracked Mobile Robot", *Proceedings of the 2007 IEEE International Conference on Mechatronics and Automation (ICMA 2007)*, Harbin, China, pp. 1374–1381, August 5–8, 2007.

Magazine / Letter / Newsletter Publications

[2] **Ben-Tzvi, P.,** Liu, Y., "Robots with Tails", *Mechanical Engineering Magazine*, Vol. 143, Issue 6, pp. 32-37, October 2021.

[1] **Ben-Tzvi, P.,** Rone, W., "Tiny Robots, Massive Potential", *IEEE Nanotechnology Newsletter*, pp. 4-7, March 2011.

Peer-Reviewed Abstracts

[8] Feng, S., **Ben-Tzvi, P.,** "A Modular Robotic System with Self-Reconfiguration Strategy", *Southeast Control Conference 2021 (SECC 2021)*, Blacksburg, VA, November 29-30, 2021.

[7] Xu, W., **Ben-Tzvi, P.,** "Data Driven Calibration and Model-based Backlash Compensation of Compact Series Elastic Actuators for Robotic Exoskeleton Gloves", *Southeast Control Conference 2021 (SECC 2021)*, Blacksburg, VA, November 29-30, 2021.

[6] Pressgrove, I., **Ben-Tzvi, P.,** "Development of a Compact and Easily Packageable Serpentine Robotic Tail System", *Southeast Control Conference 2021 (SECC 2021)*, Blacksburg, VA, November 29-30, 2021.

[5] Liu, Y., **Ben-Tzvi, P.,** "Towards Dynamic Locomotion of Legged Robots Using Biomimetic Articulated Robotic Tails", *2021 Annual Symposium of the Society for Integrative and Comparative Biology (SICB 2021)*, Washington, DC, January 3-7, 2021.

[4] Fisher, N., Gilbert, G., German, S., **Ben-Tzvi, P.**, "Toward Robotic-Assisted Casualty Extraction in Multi-Domain Operations*", Military Health System Research Symposium (MHSRS 2019)*, Kissimmee FL, August 2019.

[3] Rone, W.S., **Ben-Tzvi, P.**, "Design and Control of Bioinspired Articulated Robotic Tails for Stabilization and Maneuvering of Legged Robots", *Robotics Science and Systems (RSS 2018)*, Pittsburgh, PA, June 26–30, 2018.

[2] Rone, W.S., Saab, W., **Ben-Tzvi, P.**, "Serpentine Robotic Tails for Maneuvering and

Stabilizing Mobile Robots", *Proceedings of the 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2017)*, Vancouver, Canada, pp. 5487, Sep. 24–28, 2017.

[1] Kamidi, V., **Ben-Tzvi, P.**, "Experimental Validation of Dynamic Legged Locomotion Utilizing a Single-DOF Robotic Leg", *Proceedings of the 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2017)*, Vancouver, Canada, pp. 5504, Sep. 24–28, 2017.

Monographs/Books

[2] **Ben-Tzvi, P.,** Hybrid Mobile Robot Systems: Symbiosis of Locomotion and Manipulation. Germany: LAP LAMBERT Academic Publishing, 2010 (ISBN-13: 978-3-8433-6890-2)

[1] **Ben-Tzvi, P.,** A Dispensing System for Microdrops Generation in Medical Applications. Germany: LAP LAMBERT Academic Publishing, 2010 (ISBN-13: 978-3-8383-6000-3)

Book Chapters

[1] **Ben-Tzvi, P.**, Moubarak, P., "A Mechatronic Perspective on Robotic Arms and End-Effectors" in Intelligent Mechatronics. Vienna, Austria: InTech Open Access Publisher, 28 Feb. 2011, pp. 3–20. (ISBN-13: 978-953-307-300-2, DOI: 10.5772/16234)
Note: this book chapter has been downloaded over 7197 times as of December 2016.

Refereed Conference Posters / Video Proceedings

[6] Kamidi, V., **Ben-Tzvi, P.**, "Experimental Validation of Dynamic Legged Locomotion Utilizing a Single-DOF Robotic Leg", *Proceedings of the 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2017)*, Vancouver, Canada, Sep. 24–28, 2017 – Poster Presentation.

[5] Rone, W.S., Saab, W., **Ben-Tzvi, P.**, "Serpentine Robotic Tails for Maneuvering and Stabilizing Mobile Robots", *Proceedings of the 2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2017)*, Vancouver, Canada, Sep. 24–28, 2017 – Poster Presentation.

[4] Moubarak, P., Ma, Z., **Ben-Tzvi, P.,** "A Tri-state Rigid Reversible and Non-Back-Drivable Docking Mechanism for Modular Robotics Applications," *Proceedings of the 2012 ASME International Design Engineering Technical Conferences & Computers and Information in Engineering Conference (IDETC/CIE 2012), 36th Mechanisms & Robotics Conference,* Chicago, IL, Aug. 12–15, 2012 – Poster Presentation.
****** Second place winner of the Graduate Robotics & Mechanisms Category******

[3] Moubarak, P., Barsky, D., **Ben-Tzvi, P.,** Zaghloul, M., "A Self-Calibrating Temperature Independent Model of a Bi-Axial Piezoelectric MEMS Tilt-Sensor," *Proceedings of SPIE - Defense, Security, and Sensing, Micro- and Nanotechnology Sensors, Systems, & Applications IV Conf.*, Vol. 8373-93, Baltimore, MD, April 23-27, 2012 – Poster Presentation.

[2] Rone, W., **Ben-Tzvi, P.,** "MEMS-Based Microdroplet Generation with Integrated Sensing", *COMSOL Conference*, Boston, MA, October 13-15, 2011 – Poster Presentation.

[1] **Ben-Tzvi, P.**, Cole, K, Gilman, C., Goktas, H., Haque, S., Ma, Z., Moubarak, P., Ouellette, J., Rone, W., Sharathi, S., Torrey, J., Zambrana, E., "RAIL: Robotic Arm for Interactive Learning", *Proceedings of the 2011 ASME International Design Engineering Technical*

Conferences & Computers and Information in Engineering Conference (IDETC/CIE 2011), Washington, DC, Aug. 28–31, 2011 – Poster Presentation.
****** Third place winner of the Graduate Robotics & Mechanisms Category******

Invited Keynote Lectures / Research Presentations and Seminars

[29] *Novel Field Robots and Robotic Exoskeletons: Design, Control and Applications,* University of Virginia, Department of Mechanical and Aerospace Engineering, Charlottesville, VA, March 30, 2023. (Invited Research Presentation)

[28] *Novel Field Robots and Robotic Exoskeletons: Design, Integration and Applications,* Florida State University, Department of Mechanical Engineering, Tallahassee, FL, May 5, 2022. (Invited Research Presentation)

[27] *Novel Field Robots and Robotic Exoskeletons: Design, Integration and Applications,* Northeastern University, Department of Mechanical and Industrial Engineering, Boston, MA, February 28, 2022. (Invited Research Presentation)

[26] Towards Dynamic Locomotion of Legged Robots Using Biomimetic Articulated Robotic Tails, *2021 Annual Symposium of the Society for Integrative and Comparative Biology (SICB 2021)*, Washington, DC, January 3-7, 2021. (***Invited Symposium Speaker***)

[25] *Novel Field Robots and Robotic Exoskeletons: Design, Integration and Applications,* 2020 SPIE Smart Structures and Nondestructive Evaluation (EAPAD 2020) Conference, Anaheim, CA, April 26-30, 2020. (***Keynote Presentation***)

[24] *Novel Field Robots and Robotic Exoskeletons: Design, Integration and Applications,* Stevens Institute of Technology, Department of Mechanical Engineering, Hoboken, NJ, February 8, 2019. (Invited Research Presentation)

[23] *Novel Field Robots and Robotic Exoskeletons: Design, Integration and Applications,* University of Waterloo, Department of Mechanical and Mechatronics Engineering, Waterloo, Ontario, Canada, January 18, 2019. (Invited Research Presentation)

[22] *Design and Control of Bioinspired Articulated Robotic Tails for Stabilization and Maneuvering of Legged Robots,* Carnegie Mellon University, *Robotics Science and Systems Conference (RSS 2018),* Pittsburgh, PA, June 26–30, 2018. (Invited Workshop Presentation on “Unusual Appendages: Novel, multi-modal, or multi-functional uses for limbs, tails, and other body parts”)

[21] *Novel Field Robots and Robotic Exoskeletons: Design, Integration and Applications,* The Jet Propulsion Laboratory (JPL), California Institute of Technology, Pasadena, CA, March 4-6, 2018. (Invited Research Presentation)

[20] *Recent Trends on Modeling and Integration of Novel Field Robots and Robotic Exoskeletons and Their Applications,* 2018 International Conference on Mechatronics Systems and Control Engineering (ICMSCE 2018), Amsterdam, Netherlands, February 21-23, 2018. (***Keynote Lecture***)

[19] *Integrating Novel Field Robots and Robotic Exoskeletons of the Future,* Maxon Precision Motors, Inc. Annual Executive Meeting, Washington, DC, June 1, 2016. (Invited Research Presentation)

[18] *Novel Field Robots and Robotic Exoskeletons: Design, Integration and Applications,*

University of Toronto, Department of Mechanical and Industrial Engineering, Toronto, ON, Canada, February 26, 2016. (***Distinguished Seminar Series*** – Research Presentation)

[17] *Novel Field Robots and Robotic Exoskeletons: Design, Integration and Applications,* Vanderbilt University, Department of Mechanical Engineering, Nashville, Tennessee, October 19, 2015. (Invited Research Presentation)

[16] *Intelligent Biomimetic Flexible Robots for Stabilizing and Agile Maneuvering of Legged Robots,* Virginia Tech, Center for Bioinspired Science and Technology (BIST), Blacksburg, VA, October 9, 2015. (Research Presentation)

[15] *Novel Field Robots and Robotic Exoskeletons: Design, Integration and Applications,* Virginia Tech, Virginia Center for Autonomous Systems (VaCAS), Blacksburg, VA, October 9, 2015. (Invited Research Presentation)

[14] *Design and Integration of Novel Field Robots and Robotic Exoskeletons,* University of Maryland, Maryland Robotics Center, Department of Mechanical Engineering, College Park, MD, April 24, 2015. (Invited Research Presentation)

[13] *Design and Integration of Novel Field Robots and Robotic Exoskeletons,* State University of New York at Buffalo (UB), Mechanical and Aerospace Engineering Department, Buffalo, NY, March 12, 2015. (Invited Research Presentation)

[12] *Design and Integration of Novel Field Robots and Robotic Exoskeletons,* Worcester Polytechnic Institute, Mechanical Engineering Department, Robotics Engineering Department, Worcester, MA, March 9, 2015. (Invited Research Presentation)

[11] *Design and Integration of Novel Field Robots and Robotic Exoskeletons,* Virginia Tech, Department of Mechanical Engineering, Blacksburg, VA, March 2, 2015. (Invited Research Presentation)

[10] *Design and Integration of Novel Field Robots and Robotic Exoskeletons,* University of California, San Diego, Department of Mechanical & Aerospace Engineering, San Diego, CA, February 27, 2015. (Invited Research Presentation)

[9] *Symbiosis of Mobile Robotic Locomotion and Manipulation on Rough Terrain - Towards Modularity and Reconfigurability*, State University of New York at Buffalo (UB), Mechanical and Aerospace Engineering Department, Buffalo, NY, February 28, 2013. (Invited Research Presentation)

[8] *Autonomous Symbiosis of Mobile Robotic Locomotion and Manipulation on Rough Terrain,* DARPA Defense Sciences Office Maximum Mobility and Manipulation (M3) Conference, Philadelphia, Pennsylvania, July 17-18, 2012. (Invited Research Presentation)

[7] *STORM: Self-configurable and Transformable Omni-directional Robotic Modules for Rough Terrain Maximum Mobility and Manipulation,* Carnegie Mellon University (CMU), Robotics Institute, Pittsburgh, PA, March 5, 2012. (Invited Research Presentation)

[6] *Autonomous Symbiosis of Mobile Robotic Locomotion and Manipulation on Rough Terrain,* DARPA Defense Sciences Office Maximum Mobility and Manipulation (M3) Conference, Miramar Beach, FL, January 24-25, 2012. (Invited Research Presentation)

[5] *Symbiosis of Mobile Robotic Locomotion and Manipulation on Rough Terrain,* 2011 Symposium on Advanced Intelligent Systems, University of Waterloo, Waterloo, Canada,

December 1-2, 2011. (***Keynote Lecture***)

[4] *Sensor-Controlled Autonomous Compounded Manipulation and Locomotion of Mobile Robots,* Örebro University*,* School of Science and Technology, Centre for Applied Autonomous Sensor Systems (AASS), Sweden, September 10, 2008. (Research Talk)

[3] *Autonomous Mobile Manipulation for Rough-Terrain Environments,* Mälardalen University, Intelligent Sensor Systems Division, Eskilstuna, Sweden, Sep. 11, 2008. (Research Talk)

[2] *Hybrid Mobile Robot System for Field Operations: Interchanging Locomotion and Manipulation,* Robotdalen Day, Volvo CE Democenter*,* Eskilstuna, Sweden, Sep 10, 2008. (Research Presentation)

[1] *Wireless Hybrid Mobile Robot system: Adaptive and Interchanging Locomotion and Manipulation*, The George Washington University, Washington, DC, March 2008. (Invited Research Presentation)

Outreach Presentations (in my role as Program Director at NSF)

[1] *Robotics Research Funding Opportunities in the Established Program to Stimulate Competitive Research (EPSCoR)*, *Proceedings of the 2023 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS2023)***,** Detroit, MI, October 1-5, 2023.

[2] *Navigating Research Funding Opportunities in the Established Program to Stimulate Competitive Research (EPSCoR)*, Mississippi State University, National Science Foundation (NSF) Days, Starkville, Mississippi, November 21-22, 2022.

Other Conference /Scholarly/Technical Presentations

[1] Guo, Y., Xu, W., **Ben-Tzvi, P.**, "Medical Robotic Exoskeleton Glove Designed for Patients with Hand Disabilities", *2022 Association for Uncrewed Vehicle Systems International (AUVSI) Ridge & Valley Conference: Partnerships for Autonomy*, Blacksburg, VA, October 25, 2022.

[2] **Ben-Tzvi, P.**, "Field Performance of an Articulated Mobile Manipulator for Rough Terrain Applications", *Association for Unmanned Vehicle Systems International (AUVSI) Conference*, Denver, CO, August 24–27, 2010.

[3] **Ben-Tzvi, P.**, "Mobile Robots for Security and Defense", *National Defense Industrial Association (NDIA) 2010 Ground Robotics Capabilities Conference & Exposition*, Miami, FL, March 16–18, 2010.

[4] **Ben-Tzvi, P.**, "Demonstrations of a Mobile Robot with Compounded Mobility and Manipulation Capabilities", *Robotics Technology Consortium (RTC) Annual Meeting*, Miami, Florida, March 16, 2010.

[5] **Ben-Tzvi, P.**, "Experimental Validation and Performance Metrics of a Hybrid Mechanism Mobile Robot, *Standard Test Methods for Response Robots Meeting, ASTM International Committee on Homeland Security Applications, National Institute of Standards and Technology (NIST), Intelligent Systems Division*, Gaithersburg, MD, June 8–10, 2009.

[6] **Ben-Tzvi, P.**, "Field Performance Metrics of a Novel Hybrid Mobile Robot System", *National Institute of Standards and Technology (NIST), Intelligent Systems Division*, Gaithersburg, MD, March 16, 2009.

[7] **Ben-Tzvi, P.**, "Swarms of Autonomously Self-Assembling Mobile Robots for Search & Rescue Missions"*, National Science Foundation (NSF), Robust Intelligence Cluster, Information and Intelligent Systems*, Arlington, Virginia, February 27, 2009.

[8] **Ben-Tzvi, P.**, "Proposal for Study on Autonomous Coupling of Navigation & Locomotion for a Hybrid Mechanism Mobile Robot*", Defense Advanced Research Projects Agency (DARPA), Information Processing Techniques Office (IPTO)*, Arlington, Virginia, Jan. 23, 2009.

[9] **Ben-Tzvi, P.**, Goldenberg, A.A., "Mobile Robots with Hybrid Configuration for Military and Security Applications," *3rd Annual Conference on Robotics and Unmanned Systems*, Washington, DC, May 16-18, 2007.

[10] **Ben-Tzvi, P.**, Ben Mrad, R., Goldenberg, A.A., "A Dispensing System for Microdrops Generation in Genomics and Proteomics Applications", *MMO Partnership Conference 2004*, Toronto Congress Centre, Toronto, Ontario, June 22, 2004.

Technical Reports

[1] *Self-driving Modular AI-based Robot for Rough Terrain (SMARRT),* Defense Advanced Research Projects Agency (DARPA), Contract # FA8100-19-P-0022, March 2021.

[2] *Semi-Autonomous Victim Extraction Robot (SAVER) Design*, US Army Medical Research and Materials Command (USAMRMC/TATRC), Contract # W81XWH-16-C-0062, Sep 2018.

[3] *Symbiosis of Locomotion and Manipulation with Hybrid Mechanisms Mobile Robot,* Defense Advanced Research Projects Agency (DARPA), Contract # HR0011-11-1-0012, July 2013.

[4] *Autonomous Symbiosis of Mobile Robotic Locomotion and Manipulation,* Defense Advanced Research Projects Agency (DARPA), Contract # HR0011-11-1-0012, July 2012.

[5] *Field Experimental Results of a Hybrid Mechanism Mobile Robot,* Defense Advanced Research Projects Agency (DARPA), Contract # HR0011-09-1-0049, March 2011.

[6] *Study on Autonomous Coupling of Navigation & Locomotion for a Hybrid Mechanism Mobile Robot,* Defense Advanced Research Projects Agency (DARPA), Contract HR0011-09-1-0049, Feb 2010.

[7] *A Dispensing System for Microdrops Generation for Genomics and Proteomics Applications*, prepared for Materials & Manufacturing Ontario (MMO) Collaborative Project with Engineering Services Inc. (ESI), MMO Final Technical Report, July 2004.

[8] *Survey on Droplet Generators – Assessment of Technologies and Applications*, MMO Technical Report, Toronto, Canada, September 2002.

Sponsored Research Funding

Total Extramural funding: $4,225,471
Personal Share: $2,445,286

Project title	Sponsor	PI	Funding Amount	Project Duration	Status
Robotic Hand Orthosis Providing Grasp Assistance for Patients with Brachial Plexus Injuries	**NIH –** National Institutes of Health Award # R21HD095027	Ben-Tzvi, P., Bravo, C (co-PI)	**$393,823**	5/6/19 – 04/30/21	Complete
Closing the Loop between Robust Control of Agile Legged Robots and Bioinspired Robotic Tails: A Hybrid Systems Approach for Intrinsic Coupling	**NSF** – National Science Foundation Award # 1906727	Ben-Tzvi, P., Akbari (Co-PI)	**$396,036** (my portion $244,366)	5/10/19-05/31/22	Complete
Collaborative Modular Robot Teammates for Shipboard Inspection and Maintenance	**ONR** – Office of Naval Research (DOD - Navy - SECNAV) Award # N00014-19-1-2026	Ben-Tzvi, P., Furukawa, T (PI for UVA)	**$416,924** (my portion $58,497)	1/01/20 – 12/31/21	Complete
Phase I: Self-driving Modular AI-based Robot for Rough Terrain (SMARRT)	**DARPA** – Defense Advanced Research Projects Agency (Through Intelligent Automation Inc.) Contract # FA8100-19-P-0022	Ben-Tzvi, P. (VT), Charifa, S. (IAI)	**$225,000** (my portion $90,000)	4/1/20-3/31/21	Complete
Phase II SBIR: Design of a Mobile Robot for LIFELINE-equipped Squad – Multipurpose Equipment Transport UGV	**U.S. Army** Medical Research and Material Command - Through RE2, Inc. Phase II SBIR Award # W81XWH-16-C-0062	Ben-Tzvi, P.	**$200,028**	10/2016 - 09/2018	Complete
MRI: Development of a System for High-Resolution Uninterrupted Capture of Complex Animal Motions	**NSF** – National Science Foundation	R. Muller, Ben-Tzvi (Senior Personnel) +8 other SP	**$265,666** (my portion $25,000)	10/2018-9/2020	Active/ Ongoing

Trawl-Resistant Self-Mooring Autonomous Underwater Vehicle (AUV)	**NAVO –** US Naval Oceanographic Office	Ben-Tzvi, P. (Co-PI), Stilwell, D. (PI)	**$379,057** (my portion $71,373)	05/2017-05/2018	Complete
Active Dynamic Continuum Tails for Maneuvering and Stabilizing Legged Robots	**NSF** – National Science Foundation Award #1334227/ 1557312	Ben-Tzvi, P.	**$307,672**	09/2013-08/2017	Complete
IRES: US-China Collaboration: Bats as Model Organisms for Bioinspired Engineering	**NSF** – National Science Foundation	R. Muller, Ben-Tzvi (Senior Personnel) +11 other SP	**$250,000** (my portion $20,000)	02/2017-01/2020	Active/ Ongoing
Analysis of Ship Air Wakes with UAVs	**ONR –** Office of Naval Research Grant # N00014-15-1-2043	Ben-Tzvi, P. (Co-PI), Snyder, M.R (PI)	**$655,000** (my portion $356,759)	01/2015-01/2018	Complete
Development of Two-Finger Haptic Glove Exoskeleton for Delivery of Somatosensory Stimuli for Measurement of Cortical Responses in Neurologically Impaired Children	**NCH -** Nationwide Children's Hospital Research Institute**,** Through National Institutes of Health **(NIH)**	Ben-Tzvi, P.	**$50,028**	02/2016 - 10/2016	Complete
A Mechatronics Measurement System and Data Processing for Ship Air Wake Studies with UAVs	**USN** – United States Navy Grant # N00189-12-P-1183	Ben-Tzvi, P.	**$244,030**	08/2012-02/2015	Complete
Autonomous Symbiosis of Robotic Locomotion & Manipulation	**DARPA**– Defense Advanced Research Projects Agency Grant #HR0011-11-1-0012	Ben-Tzvi, P.	**$100,000**	09/2011-04/2013	Complete
Study on Autonomous Coupling of Navigation and Locomotion for a Hybrid Mechanism Mobile Robot	**DARPA** – Defense Advanced Research Projects Agency Grant #HR0011-09-1-0049	Ben-Tzvi, P.	**$299,707**	07/2009-12/2010	Complete
Kinetic Universal Robotic Assistive Joint	GWIBE – GW Institute for Biomedical Eng.	Ben-Tzvi, P.	**$10,000**	11/2010-07/2011	Complete
A Precise Piezeceramic Actuated Dispensing Array for Microdrops Generation and a Vision Based Testing	UFF/Dilthey Award – GWU Facilitating Fund	Ben-Tzvi, P.	**$20,000**	07/2009-08/2010	Complete

EXHIBIT A

Setup					
Application of Electroactive Polymer (EAP) Artificial Muscles for Development of Bioinspired Walking Micro-Mobile Robot	COBRE – GW Center for Biomimetics and Bioinspired Engineering	Ben-Tzvi, P.	**$12,500**	01/2009-12/2009	Complete

Other Awards and Recognitions

Awards of graduate students whose research I am directing

Torgersen Graduate Research Excellence Award, Finalist May 2022
Prof. Ben-Tzvi's doctoral student, Mr. Yujiong Liu, was selected for an oral and poster presentation category of the Torgersen Graduate Research Award for the research entitled "Novel Legged Robots with a Serpentine Robotic Tail: Modeling, Control, and Implementations". He was one among the 3 selected from all PhD applicants in the College of Engineering.

Torgersen Graduate Research Excellence Award, Poster May 2019
Prof. Ben-Tzvi's doctoral student, Mr. Bijo Sebastian, was selected for the poster presentation category of the Torgersen Graduate Research Award for the research entitled "Traversability Estimation Techniques for Improved Navigation of Tracked Robots". He was one among the 8 selected from 59 PhD applicants in the College of Engineering.

GW Research Day, 1st place April 2014
Prof. Ben-Tzvi's doctoral student, Mr. Will Rone, won 1st place for the research entitled "Biomimetic Robotic Tails for Agile Maneuvering of Field Mobile Robots"
Article published by *GW Today* in Summer 2014 issue pg. 11 is available here: http://bit.ly/1e87Gui

ASME Graduate Mechanism & Robot Design Competition, 2nd place August 2012
Prof. Ben-Tzvi's doctoral student, Mr. Paul Moubarak, presented his research project titled "A Tri-state Rigid Reversible and Non-Back-Drivable Docking Mechanism for Modular Robotics Applications" at the ASME IDETC/CIE 2012, August 12-15, Chicago, IL and won 2nd place

SEAS/GWU R&D Showcase, 3rd place February 2012
for the research entitled "STORM: Self-configurable and Transformable Omni-directional Robotic Modules", Article available here: http://bit.ly/yVNEXh
(with Doctoral Student Paul Moubarak)

Mechanism & Robot Design Competition, 3rd place August 2011
Students from my graduate robotics course presented their class project entitled "RAIL – Robotic Arm for Interactive Learning", at the ASME IDETC/CIE 2011, August 28-31, Washington, DC and won 3rd place
https://sites.google.com/site/asmesmrdc/past-winners

Recognitions & Media Coverage

Media Coverage, Research Profile Social Posts ***LinkedIn/Instagram*** October 2023
Eunice Kennedy Shriver National Institute of Child Health and Human Development, National Institutes of Health, NIH/NICHD
Posts available at: LinkedIn post 1/2; LinkedIn post 2/2; Instagram post 1/2; Instagram post 2/2; Twitter thread

Media Coverage, Featured Article in ***Virginia Tech News Daily*** January 2023
Article titled "Pinhas Ben-Tzvi, a professor and researcher in mechanical engineering,

is partnering with physician Cesar Bravo of Carilion Clinic to develop a new tool for those who have suffered a brachial plexus injury", January 12, 2023 Issue.
Article available at: https://tinyurl.com/52x5pmur

Media Coverage, Featured Video in ***Virginia Tech ME LinkedIn*** December 2022
Article titled "Pinhas Ben-Tzvi teamed up with Carilion Clinic to create a robotic hand for use by those with brachial plexus injuries", December 7, 2022.
Article available at: https://tinyurl.com/2p9fcpwn

Media Coverage, Featured Article in ***Virginia Tech News Daily*** September 2022
Article titled "Inventor Spotlight: Pinhas Ben-Tzvi, professor of mechanical engineering", September 27, 2022 Issue.
Article available at: https://www.vt.edu/link/license/faculty-inventors/pinhas-ben-tzvi.html

Media Coverage, Cover Article Featured in ***VT/ME Momentum Magazine*** July 2022
Article titled "Pinhas Ben-Tzvi named Fellow of the ASME",
Vol. 7, Issue 1, pp. 15, Spring 2022. Article available at: https://bit.ly/3zFTjdh

Media Coverage, Featured Article in ***Virginia Tech News Daily*** March 2022
Article titled "Pinhas Ben-Tzvi named fellow of the American Society of Mechanical Engineers", March 15, 2022 Issue.
Article available at: https://tinyurl.com/mu8zpv5j

Media Coverage, Article Featured in ***VT/ME Annual Report*** Dec. 2021
Article titled "Robots with Tails"
December 2021 Issue. Article available at: https://bit.ly/3Dw1I30

Media Coverage, Article Featured in ***Mechanical Engineering Magazine*** Oct. 2021
Article titled "Robots with Tails", Vol. 143, Issue 6, pp. 32-37, October/November 2021.
Article available at: https://www.asme.org/topics-resources/content/engineers-could-put-tails-on-robots

Media Coverage, Cover Article Featured in ***VT/ME Annual Report*** Dec. 2018
Article titled "Robotic Tails: High-Tech Tails May Provide Bio-Inspired Solution to Robot Stability",
December 2018 Issue. Article available at: https://vtechworks.lib.vt.edu/handle/10919/81207

Media Coverage, Cover Article Featured in ***VT/ME Momentum Magazine*** June 2018
Article titled "Tails: The evolution of robots? Robotic tails facilitate robot movement",
Vol. 3, Issue 2, pp. 10-15, Summer 2018. Article available at: https://joom.ag/c9jY

Media Coverage, Article Featured in ***Roanoke Times*** May 2018
Article titled "Virginia Tech animal-inspired robot tails",
May 14, 2018 issue. Article available at: https://bit.ly/2Gdi6rq

Media Coverage, Article Featured in ***VT/ME Momentum Magazine*** June 2017
Article titled "UG lab gets students engaged in robotics",
Vol. 2, Issue 2, pp. 23, Summer 2017. Article available at: https://joom.ag/1sBW

Media Coverage, Featured Article in ***Virginia Tech News Daily*** April 2017
Article titled "New robotics teaching lab enhances engineers' skills", April 10, 2017 Issue.
Article available at: https://vtnews.vt.edu/articles/2017/04/me-roboticsteachinglab.html

Media Coverage, Featured Video and Article in ***WDBJ-7 CBS-Affiliated TV Station*** June 2016

Article titled “Exoskeleton glove developed at Virginia Tech could diagnose cerebral palsy in children”, June 17, 2016.
Video/Article available at: http://www.wdbj7.com/content/news/love-modified-to--383468791.html

Media Coverage, Featured Article in ***Cerebral Palsy News Today*** June 2016
Article titled “Cerebral Palsy Might Be Detected in Toddlers with Glove by Exoskeleton Engineer”, June 22, 2016 Issue.
Article available at: http://bit.ly/2kOU0Mi

Media Coverage, Featured Article in ***3D Printer and 3D Printing News*** June 2016
Article titled “VT engineer 3D prints robotic exoskeleton glove to help cerebral palsy diagnosis in children”, June 23, 2016 Issue.
Article available at: http://bit.ly/28RVu3H

Media Coverage, Featured Article in ***Global News Connect*** June 2016
Article titled “Engineer Modifies Robotic Exoskeleton Glove to Assistance Intelligent Palsy Diagnosis in Children”, June 13, 2016 Issue.
Article available at: http://bit.ly/2fDTxf1

Media Coverage, Featured Article in ***ASEE* First Bell Magazine*** June 2016
Article titled “Virginia Tech Engineer Develops Robotic Exoskeleton Hand to Diagnose Children”, June 21, 2016 Issue.
Article: http://mailview.bulletinmedia.com/mailview.aspx?m=2016062101asee&r=2892555-5e40
** ASEE – American Society of Engineering Education*

Media Coverage, Article Featured in ***VT/ME Momentum Magazine*** July 2016
Article titled “Exoskeleton to help cerebral palsy diagnosis in children”,
Vol. 1, Issue 2, pp. 12, July 2016. Article available at: http://bit.ly/2aytqSW

Media Coverage, Featured Article in ***Virginia Tech News Daily*** June 2016
Article titled “Engineer modifies robotic exoskeleton glove to help cerebral palsy diagnosis in children”, June 10, 2016 Issue.
Article available at: https://vtnews.vt.edu/articles/2016/06/me-roboticdiagnosticglove.html

Recognition, Robotics and Mechatronics Laboratory (RML) December 2013
Cited on the newly published list of 99 Superb Sites on Mechatronics & Robotics Engineering,
http://www.electricalengineeringschools.org/mechatronics

Media Coverage, Featured Article in ***GW Alumni Magazine*** June 2013
Article titled “The Body Robotics”, Summer 2013 Issue, pp. 56-59.
Article available at: http://magazine.gwu.edu/body-robotic

Media Coverage, Featured Article in ***GW Research Magazine*** April 2013
Article titled “The Body Robotics: Form, function, and the future as seen through the eyes and handiwork of three GW roboticists”, Spring 2013 Issue, pp. 19-23.
Article available at: http://www.gwu.edu/~magazine/2013_research_spring/feature1.html

Media Coverage, television interview to ***CTV News (Canadian Television Network)*** Nov. 2012
Live interview on The Advancement of Robots
Interview available at: http://bit.ly/1yU7DX2

Media Coverage, blog posting on the ***Scientific American*** May 2012
Article titled “School Turns Engineering Faculty into Superheroes”
Article available at: http://bit.ly/KzAADF

Media Coverage, GW's Newspaper published by ***GW Today*** April 2012
Article titled "Engineering Interest - New SEAS marketing campaign uses superheroes to highlight ground-breaking research"
Article available at: http://bit.ly/KrooQr

Newspaper Article, published by ***The GW Hatchet*** April 2012
"SEAS shows off 'superhero' engineers", Vol. 108, Issue 56, pp. 3, Apr 16, 2012
Featured article on my research on modular and reconfigurable mobile robotics
Article available at: http://bit.ly/HLUGJB

Media Coverage, published by ***SEAS/GWU*** April 2012
SEAS features Prof. Ben-Tzvi as a "superhero" – RobotronMan
Article available at: http://bit.ly/1AfmE89

Media Coverage, Featured Article by ***The GW Hatchet*** April 2012
Robotics Workshop for GW's Science, Technology and Engineering Day
Article available at: http://bit.ly/HHnTmz

Media Coverage, GW's Newspaper published by ***GW Today*** March 2012
For winning 3rd place in the GWU SEAS R&D Showcase
Article available at: http://bit.ly/yVNEXh

Media Coverage, radio interview to ***China Radio International*** December 2011
Live, hour-long panel discussion on Robot Revolution
Interview available at: http://english.cri.cn/8706/2011/12/09/2861s670868.htm

Media Coverage, Television interview for ***Voice of America*** August 2011
Covered ongoing research activities in the Robotics and Mechatronics Lab
Video and article available at: http://bit.ly/uHXKPz

Media Coverage, Featured Video and Article at ***Loudoun Times*** April 2011
Robotics Workshop for GW's Science, Technology and Engineering Day
Article and video available at: http://bit.ly/e94yNk

Media Coverage, Featured Article at ***Leesburg Today*** April 2011
Robotics Workshop for Loudon county high school students as part of GW's Science, Technology and Engineering Day at the Virginia Science and Technology Campus
Article available at: http://bit.ly/odlyXJ

Media Coverage, radio interview on the show ***Today on Beyond Beijing*** January 2011
Panel discussion featuring international experts on the future of robotics
Interview available at: http://english.cri.cn/8706/2011/01/07/481s613923.htm

Featured in GW's Newspaper published by ***GW Today*** August 2010
Article titled "The Robot Revolution"
Article available at: http://gwtoday.gwu.edu/robot-revolution

Featured in 2010 issue of SEAS ***Synergy Magazine*** (pg. 6) showcasing my research activities at the GW Robotics and Mechatronics Lab July 2010

Featured in the SEAS Video highlighting my research in the *Robotics & Mechatronics Lab in SEAS* May 2010
http://www.rmlab.org/bentzvi_GW_video.php
* Video used as a media content for various audiences including graduate and undergraduate recruiting, raising funds for SEAS from prospective donors and keeping alumni engaged

EXHIBIT A

Featured photos of the Robotics and Mechatronics Lab *SEC (Science and Engineering Hall) Brochure* highlighting students' research work in robotics and mechatronics — April 2010

Student Supervision

Graduated Ph.D. Students (12)

Dates	Degree	Candidate	Dissertation Title	Current Position
Dec. 2020 – Sep. 2023	Ph.D.	Yunfei Guo (ECE)	Vision-Based Force Planning and Voice-Based Human-Machine Interface of an Assistive Robotic Exoskeleton Glove for Brachial Plexus Injuries	Senior Robotics System Engineer, Futronics Corp., Pasadena, USA
Aug. 2019 – Sep. 2023	Ph.D.	Wenda Xu	Design, Development, and Control of an Assistive Robotic Exoskeleton Glove Using Reinforcement Learning-Based Force Planning for Autonomous Grasping	Senior Control and Manipulation Engineer, Futronics Corp., Pasadena, USA
Aug. 2017 – May 2022	Ph.D.	Yujiong Liu	Novel Legged Robots with a Serpentine Robotic Tail: Modeling, Control, and Implementations	Robotic System Engineer, Cornerstone Medical USA Inc.
May 2017 – Dec. 2021	Ph.D.	Shumin Feng	Design, Analysis, Planning, and Control of a Novel Modular Self-Reconfigurable Robotic System	Staff Robotics Engineer, DIMAAG-AI
Jan. 2018 – Dec. 2020	Ph.D.	Taylor Njaka	Design, Simulation, and Experimental Validation of a Novel High-Speed Omnidirectional Underwater Propulsion Mechanism	Postdoctoral Researcher at Virginia Tech
Sep. 2016 – Mar. 2020	Ph.D.	Hailin Ren	Human-Robot Interaction with Pose Estimation and Dual-Arm Manipulation Using Artificial Intelligence	Senior Software Engineer, MathWorks
Jan. 2016 – Sep. 2019	Ph.D.	Bijo Sebastian	Traversability Estimation Techniques for Improved Navigation of Tracked Mobile Robots	Assistant Professor, Indian Institute of Technology, Madras
Sep. 2012 – Mar. 2018	Ph.D.	Wael Saab	Design and Implementation of Articulated Robotic Tails to Augment the Performance of Reduced Degree-of-Freedom Legged Robots	Senior Research and Development Engineer, SoftWear Automation
Jan. 2012 – Feb. 2018	Ph.D.	Anil Kumar	Estimation and Mapping of Ship Airwake Using RC Helicopters as a Sensing Platform	Senior Systems Integration Engineer, GM Cruise
Sep. 2010 – Dec. 2017	Ph.D.	William S. Rone	Hyperredundant Dynamic Robotic Tails for Stabilizing and Maneuvering Control of Legged Robots	Mechanical Engineer, US Airforce Nuclear Weapons Center
Sep. 2009 – May 2013	Ph.D.	Paul M. Moubarak	A Mobile Robot with Modular and Reconfigurable Mobility and Manipulation	Research Engineer, Ford Motor Company

Jan. 2010 – Dec. 2014	Ph.D.	Zhou Ma	Sensing and Force-Feedback Exoskeleton (SAFE) Robotic Glove Mechanism and Its Applications	Senior Robotics Engineer, US Medical Innovations Company

Graduated M.S. Students (20)

Dates	Degree	Candidate	Thesis Title
Aug. 2020 – May 2022 (VT)	M.S.	Isaac Pressgrove	A Systematic Design Methodology for Articulated Serpentine Robotic Tails to Assist Agile Robot Behaviors
Aug. 2019 – July 2021 (VT)	M.S.	Sarthak Pradhan	Design and Control of an Exoskeleton Glove Using a Neural Network Based Controller for Grasping Objects
Aug. 2019 – Dec. 2020 (VT)	M.S.	Yunfei Guo	Personalized Voice Activated Grasping System for a Robotic Exoskeleton Glove
Jan. 2019 – May 2020 (VT)	M.S.	Xiaoxue Han	Autonomous Cricothyroid Membrane Detection and Manipulation using Neural Networks and a Robotic Arm for First-Aid Airway Management
Aug. 2017 – July 2019 (VT)	M.S.	Teja Vanteddu	Grasp Stability with a Robotic Exoskeleton Glove
Aug. 2017 – May 2019 (VT)	M.S.	Shubhdildeep Singh Sohal	A Hybrid Tracking Approach for Autonomous Docking in Self-Reconfigurable Robotic Modules
Aug. 2017 – Dec. 2018 (VT)	M.S.	Jiteng Yang	A Two-DOF Bipedal Robot Utilizing the Reuleaux Triangle Drive Mechanism
May 2017 – Dec. 2018 (VT)	M.S.	Shumin Feng	Mobile Robot Obstacle Avoidance Based on Deep Reinforcement Learning
Sep. 2016 – May 2018 (VT)	M.S.	Adam Williams	A Robotic Head Stabilization Device for Post-Trauma Transport
Sep. 2016 – May 2018 (VT)	M.S.	Brielle Junghee Lee	Development of Intelligent Exoskeleton Grasping Through Sensor Fusion and Slip Detection
Jan. 2016 – Dec. 2017 (VT)	M.S.	Vinaykarthik Kamidi	Design and Integration of Novel Single Degree of Freedom Leg For Fast Locomotion
Jan. 2016 – Dec. 2017 (VT)	M.S.	Peter Racioppo	Design and Control of a Modular, Cable-Driven Snake Robot
Jan. 2016 – Dec. 2017 (VT)	M.S. (ECE)	Eric Refour	Design and Integration of a Form-Fitting General Purpose Robotic Hand Exoskeleton
Sep. 2012 – May 2014 (GW)	M.S.	Jeffrey Phillips	Exoskeleton robotic arms for rehabilitation applications

Sep. 2012 – May 2014 (GW)	M.S.	Bohua Zhang	Robotic wrist exoskeleton device for debilitated patients
Sep. 2012 – May 2014 (GW)	M.S.	Yue Sun	Modeling and simulation of micro-droplet precision devices
Sep. 2010 – May 2012 (GW)	M.S.	Chad Gilman	Medical robotics – human wrist joint assist robot
Sep. 2013 – Aug. 2015 (GW)	M.S.	Xiaofan Liu	Non-Thesis
Sep. 2013 – Aug. 2015 (GW)	M.S.	Teng Long	Non-Thesis
Sep. 2012 – May 2015 (GW)	M.S.	Olugbenga Idowu	Non-Thesis

Visiting PhD Students

Date	Candidate	Originating Institution	Topic
09/01/2019 – 10/31/2020	Xiaoyun Lei	Nanjing University of Science and Technology	Dual-arm Cooperation Manipulation with Distance Constrains using Deep Reinforcement Learning

Postdoctoral Scientists

Employed	Student	Degree and Institution	Research Topic	Employment
May 2014– Apr. 2017	Dr. Lawrence Wong	Ph.D., University of Waterloo	Micromachined Ultrasonic Transducers for Non-destructive Testing Applications	Advanced Research Engineer at Thalmic Labs
Jan. 2012– Jan. 2013	Dr. Radu Robotin	Ph.D., Technical University of Cluj-Napoca	Vision Guided Autonomous Robotic Locomotion and Manipulation	Cloud Systems Engineer at National Cancer Institute (NCI)
Feb 2010– Feb. 2011	Dr. Xianxin Ke	Ph.D., Shanghai University	Dynamic Mobility of an Omni-wheel Robots	Associate Professor at Shanghai Univ.
Nov 2009– Jan. 2011	Dr. Samer Charifa	Ph.D., North Carolina Agricultural and Technical State Univ.	Volumetric Environment Mapping Using Multi-sensor Fusion for Robotic Vision	Research Scientist at Intelligent Automation, Inc.

Visiting Professors

Date	Candidate	Originating Institution	Topic
Sep. 2010 – Sep. 2012	Prof. Jae Weon Choi	Pusan National Univ., S. Korea	Navigation, Guidance, and Control for Autonomous Vehicles

Visiting Scholars Advising

Date	Candidate	Topic
Jul. 2010 – Sep 2011	Prof. Arif Ankarali	ANFIS* Inverse Kinematics and Precise Trajectory Tracking of a Dual Arm Robot (*Adaptive Neuro Fuzzy Inference System)*
Oct. 2009 – Jan. 2010	Dr. Getachew Befekadu	Decentralized control and optimization of interconnected systems with applications to multiple robots coordination

Undergraduate Students Research Thesis/Projects Advising

Date	Candidate	Department	Research Topic
Aug. 2022 – Dec. 2022	Renrui Liu	ME/VT	Exoskeleton Robotic Glove Design for Hand Rehabilitation
May 2020 – Dec. 2021	Alex Broz	ME/VT	Design of a two-section robotic tail based on the Rigitail
May 2020 – Dec. 2021	Ruichang Chen	ECE/VT	Simulation environment development of modular and reconfigurable robots in V-Rep
Aug. 2019 – Dec 2020	Logan Stevenson	ME/VT	Upper extremity exoskeletons for robot control and rehabilitation therapy
Feb. 2019 – Dec 2020	Jonah Fike	AOE/VT	Omni-Direction Propulsion Mechanism for Underwater Vehicles
May 2019 – Dec 2020	Marco Brizzolara	Physics /VT	Omni-Direction Propulsion Mechanism for Underwater Vehicles
May 2019 – Dec 2020	Abdalla Diraz	ME/VT	Robotic Exoskeleton Glove Mechanism for Autonomous Grasping
Jan. 2019 – Dec 2020	Jingyuan Qi	Physics/VT	Machine learning application in human robot interaction and UAV
Sep. 2018 – Dec 2020	Samatar Jama	ME/VT	Semi-autonomous Robot Motion Planning
Sep. 2018 – Dec. 2018	Alex Rhee	ECE/VT	Design of Rotary SEA for Robotic Glove Exoskeleton Applications
May 2018 – Dec. 2018	Alina Voelker	ME/VT	Vision Based Localization Techniques for Ground Robots
Jan 2018 – May 2019	Kefan Li	ME/VT	Autonomous Grasping with a Robotic Exoskeleton
Nov 2017 – May 2018	Zhoubao Pang	ME/VT	Design and Integration of a Single-DOF Biped with a Rigid Robotic Tail
Nov 2017 – May 2018	Hongxu (Howard) Guo	ME/VT	Controller Design for a Single-DOF Biped Locomotion with a Robotic Tail
Jan 2017 – Dec. 2018	Nicole Gouhin	ME/VT	Review of Bio-inspired Robotic Tails
Jan 2017 –	Xinran Wang	ME/VT	Suspension Design for a Search and Rescue

EXHIBIT A

Dec. 2018			Mobile Ground Robot
May 2017 – Aug 2017	Youssef Haridy	ME/VT	Docking Mechanisms for Modular Robotic Modules
Jan 2016 – May 2017	David Evans	CEC/VT	Design of Embedded Controllers for Reconfigurable Robotic Modules
Jan 2016 – May 2017	Brock Davis	ME/VT	Modeling and Controls of a Robotic Exoskeleton Mechanism for Rehabilitation
Jan 2016 – Dec 2016	Tommy Hutcheson	ME/VT	Design and Simulation of a 2-finger Robotic Exoskeleton Mechanism for Rehabilitation
Jan 2015 – Aug 2015	Timothy Wetzel	MAE/GWU	Simulation of Robotic Tails for Maneuvering Quadruped Robots
May 2013 – Aug 2015	Cyndi-Leigh Pine	MAE/GWU	Rehabilitation robotics and computer-aided design
Jan 2014 – May 2014	Robert Forcha	MAE/GWU	Simulation of Fingers Position for Hand Rehabilitation Application
May 2011 – May 2013	Eric Alvarez	MAE/GWU	Design of docking interface for reconfigurable mobile robotic system
Sep 2011 – May 2013	Jeff Birenbaum	MAE/GWU	Synergistic Piezo Actuation
Sep 2011 – Sep 2012	Jeffrey Phillips	MAE/GWU	Continuum Robotics for Rehabilitation
Jan – May 2012	Allison Hogarth & David Perry	MAE/GWU	Moving Side View Mirror for Blind Spot Detection
Sep 2011 – Dec 2011	Jimmy Gomez	MAE/GWU	Robotic exoskeleton device for augmenting wrist movement in debilitated patients
Sep. 2010 – Sep. 2012	Danielle Barsky	MAE/GWU	Modeling and Simulation of MEMS tilt sensor
May 2011 – Sep 2011	Gabriel Yessin	ECE/GWU	Optimization of algorithms for remote control operation of a mobile robot
Sep. 2009 – Jan. 2011	Michael Shick	CS/GWU	Algorithms for mobile robot autonomous functions
May 2009 – Aug. 2010	Will Rone	MAE/GWU	Piez-actuated dispensing system for micro-drops generation in microarray applications
May–Sep 2009	Sarah Beaver	MAE/GWU	Electroactive polymers applied toward biomimetic robots
May–Dec 2009	Tim Perkins	MAE/GWU	Smart materials for the development of biomimetic micro-robots
Dec. 2009 – June 2010	Marcus Hendricks	MAE/GWU	Mechanical and electrical design layout for a mobile robot remote controller
Mar. 2010 – April 2011	Hannah Stuart	MAE/GWU	Development of a operating control unit for a mobile robot
Mar. 2010 – April 2011	Micah Foster	MAE/GWU	Development of a operating control unit for a mobile robot
Mar. 2010 – Dec 2010	Nicholas Blanton	MAE/GWU	Detailed design layout of a operating control unit components
June – Sep 2010	Brandon Fix	MAE/GWU	Perform design layouts of mechanical parts using SolidWorks

Undergraduate Interns Supervision

Date	Candidate	Originating Institution	Topic
Oct – Dec. 2010	Gustavo Ruiz, B.Sc.	Polytechnic University of Chiapas, Mexico	Hardware-in-the-loop (HIL) simulations of dual arm mobile robotic system *(Funded by the Mexican government under the Governors' Internship Program)*
Jan–Apr. 2010	Mikhail Zhuk, MechE Senior	University of California, Irvine	Modeling and simulation of robotic systems using ADAMS and ATV ToolKit
Jun–Aug. 2010	Ari Schiftan, MechE Junior	University of Miami, FL	Modeling and analysis of mechanical parts for a hybrid mobile robot using ABAQUS FEA SW

Ph.D. Dissertation External Examiner

Student Name	Thesis Title	Defense date	Institution
So-Ra Chung	MEMS Demodulator Based on Electrostatic Actuator	July 6, 2012	University of Waterloo Dept. of Systems Design Engineering

PhD/MS Thesis Reader / Committee Member/Chair

Student Name	Thesis/Dissertation Title	Level	Defense date	Advisor	Role / Institution
Wenda Xu	Design, Development, and Control of an Assistive Robotic Exoskeleton Glove Using Reinforcement Learning-Based Force Planning for Autonomous Grasping	Ph.D.	Sep. 8, 2023	Dr. P. Ben-Tzvi	Dissertation Director/ VT*
Yunfei Guo	Vision-Based Force Planning and Voice-Based Human-Machine Interface of an Assistive Robotic Exoskeleton Glove for Brachial Plexus Injuries	Ph.D.	Sep. 12, 2023	Dr. P. Ben-Tzvi	Dissertation Director/ VT*
Shumin Feng	Design, Analysis, Planning, and Control of a Novel Modular Self-Reconfigurable Robotic System	Ph.D.	Dec. 2, 2021	Dr. P. Ben-Tzvi	Dissertation Director/ VT*
Michael Molzon	Development of a Mobile Robot System for the Visual Inspection of Railcar Undercarriage Equipment	Ph.D.	June 2022	Dr. Mehdi Ahmadian	Committee Member/ VT*
Sarthak Pradhan	Design and Control of an Exoskeleton Glove Using a Neural Network Based Controller for Grasping Objects	M.S.	July 23, 2021	Dr. P. Ben-Tzvi	Thesis Director/ VT*
Yunfei Guo	Personalized Voice Activated Grasping System for a Robotic Exoskeleton Glove	M.S.	Dec. 10, 2020	Dr. P. Ben-Tzvi	Thesis Director/ VT*
Taylor Njaka	Design, Simulation, and Experimental Validation of a Novel High-Speed Omnidirectional Underwater Propulsion Mechanism	Ph.D.	Dec. 14, 2020	Dr. P. Ben-Tzvi	Dissertation Director/ VT*
Grant Carter	Adaptive Control of the Transition from Vertical to Horizontal Flight Regime of a Quad-Tailsitter UAV	M.S.	May 12, 2021	Dr. Andrea L'Afflitto	Committee Member/ VT*

Alfred Mayalu	Beyond LiDAR for Unmanned Aerial Event-Based Localization in GPS Denied Environments	Ph.D.	May 20, 2021	Dr. K. Kochersberger	Committee Member/ VT*
Kenneth E. Kroeger	Decentralized Task Allocation and Coordination of Heterogeneous UxVs Subjected to Spatiotemporally Evolving Environment	Ph.D.	TBD	Dr. K. Kochersberger	Committee Member/ VT*
Wael Saab	Design and Implementation of Articulated Robotic Tails to Augment the Performance of Reduced Degree-of-Freedom Legged Robots	Ph.D.	March 19, 2018	Dr. P. Ben-Tzvi	Dissertation Director/ VT*
Anil Kumar	Estimation and Mapping of Ship Air Wakes using RC Helicopters as a Sensing Platform	Ph.D.	Feb. 26, 2018	Dr. P. Ben-Tzvi	Dissertation Director/ VT*
William S. Rone	Hyperredundant Dynamic Robotic Tails for Stabilizing and Maneuvering Control of Legged Robots	Ph.D.	Dec. 13, 2017	Dr. P. Ben-Tzvi	Dissertation Director/ VT*
Bijo Sebastian	Traversability Estimation Techniques for Improved Navigation of Tracked Mobile Robots	Ph.D.	Sep. 19, 2019	Dr. P. Ben-Tzvi	Dissertation Director/ VT*
Hailin Ren	Human-Robot Interaction with Pose Estimation and Dual-Arm Manipulation Using Artificial Intelligence	Ph.D.	March 23, 2020	Dr. P. Ben-Tzvi	Dissertation Director/ VT*
Shumin Feng	Path Planning Algorithms and Control of Modular Mobile Robots	Ph.D.	TBD	Dr. P. Ben-Tzvi	Dissertation Director/ VT*
Yujiong Liu	Dynamics Modeling and Control of Hybrid Robotic Tail-Bipedal Systems	Ph.D.	TBD	Dr. P. Ben-Tzvi	Dissertation Director/ VT*
Negin Nikafrooz	Design, fabrication, and control of an assistive glove for farmers with mobility limitations	Ph.D.	Spring 2021	Dr. A. Leonessa	Committee Member/ VT*
Murat Ambarkutuk	Development of a Non-Line-of-Sight Perception Technique with high-frequency short range RADAR for Deformation Measurements	Ph.D.	Fall 2020	Dr. T. Furukawa	Committee Member/ VT*
Murtaza Rangwala	Control and coordination of multi-agent systems/robots using deep reinforcement learning	Ph.D.	TBD	Dr. Ryan Williams	Committee Member/ VT*
Jiteng Yang	A Two-DOF Bipedal Robot Utilizing the Reuleaux Triangle Drive Mechanism	M.S.	Nov. 16, 2018	Dr. P. Ben-Tzvi	Thesis Director/ VT*
Shumin Feng	Mobile Robot Obstacle Avoidance Based on Deep Reinforcement Learning	M.S.	Dec. 12, 2018	Dr. P. Ben-Tzvi	Thesis Director/ VT*
Adam Williams	A Robotic Head Stabilization Device for Post-Trauma Transport	M.S.	May 9, 2018	Dr. P. Ben-Tzvi	Thesis Director/ VT*

Brielle Junghee Lee	Development of Intelligent Exoskeleton Grasping Through Sensor Fusion and Slip Detection	M.S.	May 9, 2018	Dr. P. Ben-Tzvi	Thesis Director/ VT*
Peter Racioppo	Design and Integration of a Form-Fitting General Purpose Robotic Hand Exoskeleton	M.S.	Dec. 11, 2017	Dr. P. Ben-Tzvi	Thesis Director/ VT*
Vinaykarthik Kamidi	Design and Integration of Novel Single Degree of Freedom Leg For Fast Locomotion	M.S.	Dec. 19, 2017	Dr. P. Ben-Tzvi	Thesis Director / VT*
Eric Refour	Design and Integration of a Form-Fitting General Purpose Robotic Hand Exoskeleton	M.S.	Sep. 29, 2017	Dr. P. Ben-Tzvi	Thesis Director/ VT*
Teja Vanteddu	Grasp Stability with a Robotic Exoskeleton Glove	M.S.	July 24, 2019	Dr. P. Ben-Tzvi	Thesis Director/ VT*
Shubhdildeep Singh Sohal	A Hybrid Tracking Approach for Autonomous Docking in Self-Reconfigurable Robotic Modules	M.S.	May 9, 2019	Dr. P. Ben-Tzvi	Thesis Director/ VT*
Gordon Christie	Collaborative Unmanned Air and Ground Vehicle Perception for Scene Understanding, Planning and GPS-denied Localization	Ph.D.	Nov. 7, 2016	Dr. K. Kochersberger	Committee Member/ VT*
Hubert Kim	Joint Torque Feedback for Motion Training with an Elbow Exoskeleton	Ph.D.	Sep. 14, 2021	Dr. A. Asbeck	Committee Member/ VT*
Sebastien Corner	Modeling, Sensitivity Analysis, and Optimization of Hybrid, Constrained Mechanical Systems	Ph.D.	Feb. 14, 2018	Dr. Corina Sandu	Committee Member/ VT*
Adam Lowery	Enhanced Portability and Anti-Frosting Functionality of Cryostats for Synchrotron-Based X-ray Imaging	Ph.D.	June 21, 2022	Dr. Jonathan Boreyko	Committee Member/ VT*
Cong Chen	Robust Motion Tracking and Post Estimation of Combined Camera and Lidar 3D Shape	Ph.D.	TBD	Dr. T. Furukawa	Committee Member/ VT*
Mengyu Song	Specular Micro-texture Photometry for Circumferential Three-Dimensional Profiling	Ph.D.	May 19, 2020	Dr. T. Furukawa	Committee Member/ VT*
John Seminatore	Design of a Series Elastic Humanoid for the DARPA Robotics Challenge	M.S.	August 3, 2016	Dr. Al Wicks	Committee Member / VT*
Tom Ehrenzeller	Visual Servoing Using a Two Armed Robot	M.S.	TBD	Dr. T. Furukawa	Committee Member/ VT*
Chen Tang	Design of a Gravity Compensation Actuator for Arm Assistance	M.S.	Dec. 18, 2017	Dr. Alan Asbeck	Committee Member/ VT*
Yi Tian	Self-Powered Intelligent Traffic Monitoring Using IR Lidar and Camera	M.S.	Dec. 8, 2016	Dr. T. Furukawa	Committee Member/ VT*
Murat Ambarkutuk	A Grid-based Radiolocation Technique Based on Spatially Coherent Path Loss Model	M.S.	Sep. 1, 2017	Dr. T. Furukawa	Committee Member/ VT*
Bryan Todd	Comparison of the Role of Beamwidth in Biological and Engineered Sonar	M.S.	Sep. 29, 2017	Dr. R. Mueller	Committee Member/ VT*

Zhou Ma	Sensing and Force-Feedback Exoskeleton Robotic (SAFER) Glove Mechanism for Rehabilitation	Ph.D.	Dec. 15, 2014	Dr. P. Ben-Tzvi	Dissertation Director/ GWU**
Paul M. Moubarak	A Mobile Robot with Modular and Reconfigurable Mobility and Manipulation	Ph.D.	March 15, 2013	Dr. P. Ben-Tzvi	Dissertation Director/ GWU**
Robert Cortesi	Modeling and Control of Joint-Actuated Buoys	Ph.D.	Feb. 15, 2012	Dr. D. Chichka	Committee Member/ GWU**
Kenan Cole	Design, Analysis, and Optimization of an Interferometer for Extreme Ultraviolet Interference Lithography	M.S.	Nov. 10, 2010	Dr. R. Ryan Vallance	Committee Member/ GWU**
Jaime Alba-Bohorquez	Design of a Robust Altitude-Hold Controller for UAVs Using Neural Networks	M.S.	Nov. 21, 2008	Dr. D. Chichka	Committee Member/ GWU**

* VT – Virginia Tech; ** GWU – George Washington University

High School Students Mentoring

Date	Candidate	School Name	Topic
Summer 2022	Phillipe Charalanis	Blacksburg Middle School	Camera System for Human Motion Detection and Tracking
May 2019 – Dec. 2020	Kye Gonino	James River High School	Omni-Direction Propulsion Mechanism for Underwater Vehicles
Sep 2013 – May 2015	Daniel Dulaney	School Without Walls (SWW)	Omni-directional mobile robots locomotion

Teaching

Courses Taught

Virginia Tech - Department of Mechanical Engineering

Controls Engineering I (ME 3534) Spring 2022
Advanced Robotics and Automation (ME 5704/ECE 5704) Fall 2021
Robotics & Mechatronics Seminar (ME 4734) Fall 2021
Controls Engineering I (ME 3534) Spring 2021
Engineering Design and Project II (ME4016) Spring 2021
Mechanical Vibrations (ME 3524) Fall 2020
Engineering Design and Project I (ME4015) Fall 2020
Advanced Robotics and Automation (ME 5704/ECE 5704) Spring 2020
Robotics Laboratory (ME 4584/ECE 4584) Spring 2020
Robotics and Automation (ME 4524) Spring 2020
Principles of Robotics Systems (ECE 4704) Spring 2020
Advanced Robotics and Automation (ME 5704/ECE 5704) Spring 2019
Robotics Laboratory (ME 4584/ECE 4584) Spring 2019
Robotics and Automation (ME 4524) Spring 2019

Principles of Robotics Systems (ECE 4704)	Spring 2019
Advanced Robotics and Automation (ME5704/ECE 5704)	Spring 2018
Robotics Laboratory (ME 4584/ECE 4584)	Spring 2018
Robotics and Automation (ME 4524)	Spring 2018
Principles of Robotics Systems (ECE 4704)	Spring 2018
Engineering Design and Project I (ME4015)	Fall 2017
Robotics and Automation (ME 4524)	Spring 2017
Principles of Robotics Systems (ECE 4704)	Spring 2017
Robotics and Automation (ME 4524)	Spring 2016
Principles of Robotics Systems (ECE 4704)	Spring 2016
Engineering Design and Project II (ME4016)	Spring 2016
System Dynamics (ME 3514)	Fall 2015
Engineering Design and Project I (ME4015)	Fall 2015

<u>George Washington University - Department of Mechanical & Aerospace Engineering</u>

Robotic Systems (MAE 6245)	Spring 2015
Mechatronics Design (MAE 4194)	Spring 2015
Electromechanical Control System Design (MAE 4182)	Fall 2014
Robotic Systems (MAE 6245)	Spring 2014
Mechatronics Design (MAE 4194)	Spring 2014
Analysis and Synthesis of Mechanisms (MAE 3190)	Fall 2013
Robotic Systems (MAE 6245)	Spring 2013
Mechatronics Design (MAE 4194)	Spring 2013
Analysis and Synthesis of Mechanisms (MAE 3190)	Fall 2012
Robotic Systems (MAE 6245)	Spring 2012
Mechatronics Design (MAE 4194)	Spring 2012
Electromechanical Control System Design (MAE 4182)	Fall 2011
Robotic Systems (MAE 6245)	Spring 2011
Mechatronics Design (MAE 4194)	Spring 2011
Electromechanical Control System Design (MAE 4182)	Fall 2010
Mechatronics Design (MAE 4194)	Spring 2010
Introduction to Vibration Analysis (MAE 3134)	Spring 2010
Electromechanical Control System Design (MAE 4182)	Fall 2009
Introduction to Vibration Analysis (MAE 3134)	Spring 2009

<u>University of Toronto – Department of Mechanical & Industrial Engineering</u>

Computer Aided Design (MIE441)	Winter 2006, 2007, 2008

Introduction to Computer Aided Design (Short Course) Winter, Spring, Fall 2007, Winter 2008

Control Systems (MIE372) Fall 2003, 2004
Co–Instructor (with Prof. A.A. Goldenberg)

University of Toronto – Faculty of Applied Science and Engineering

Artificial Intelligence and Robotics Fall 2006

Mechatronics and Artificial Intelligence Summer 2005
Mechatronics Design and Operation Fall 2004

Mechatronics Summer 2004

Technion - Israel Institute of Technology

Instructor, Physics Courses – Mechanics July 1999–July 2000

Israeli Air Force Academy
Senior Instructor, Engineering Courses May 1993–April 1996
Courses taught: Control Systems, Mechanics and Control Lab, Mechanical Machining Lab, Hydraulics Lab, Pneumatics Lab, CNC Lab, Engineering Drafting, Computer Aided Design Lab

Teaching Expertise & Interests

The following is a selected list of my teaching experiences and interests:

System Dynamics and Control
- Analysis & Design of Feedback Control Systems
- Automatic Control Systems
- Linear & Nonlinear Control Systems
- Modeling and Simulation of Dynamic Systems

Robotics and Automation
- Industrial Automation Systems Design
- Robotic Systems Design
- Robot Kinematics, Dynamics & Control
- Design of Electromechanical Mobile Robots

Mechatronics
- Mechatronic Systems Design
- Mechatronics Principles
- Microcontroller-based Systems Design
- Sensors, Actuators & Measurement

Design and Manufacturing
- Precision Mechanism Analysis & Synthesis
- Electromechanical Machine Design
- Computer Aided Design (CAD)
- System Design & Analysis (FEA)

Core Courses
- Statics
- Dynamics and Vibrations
- Electrical Circuits

Service to Profession and Field

A. Professional Service

A1. Workshops Organized (in my role as Program Director at NSF)

[1] *NSF EPSCoR Workshop on Quantum Computing, Information, Science, and Engineering*, National Science Foundation (NSF), Alexandria, VA, March 23-24, 2023.

EXHIBIT A

A2. Conference General Chair

General Chair, IEEE International Symposium on Robotic and Sensors Environments – IEEE ROSE 2013, Washington, DC**,** 21-23 October 2013.

A3. Conference Technical Program Committees – Chair / Co-Chair

- ***Chair*** of the Technical Program Committee for the 44th Mechanisms and Robotics Conference at the 2020 ASME International Design Engineering Technical Conferences (IDETC/CIE), August 2020, St. Louis, MO, USA.
- ***Co-Chair*** of the Technical Program Committee for the 43rd Mechanisms and Robotics Conference at the 2019 ASME International Design Engineering Technical Conferences (IDETC/CIE), August 2019, Anaheim, CA, USA.
- ***Chair*** for Workshops, Tutorials and Special Sessions for the 2017 ASME Dynamic Systems and Control Conference – DSCC 2017, Tysons Corner, VA, 11-13 Oct. 2017.
- ***Co-Chair*** of the Technical Program Committee for the 10th IEEE International Symposium on Robotic and Sensors Environments – ROSE 2012, Magdeburg, Germany, 16-18 Nov. 2012.
- ***Co-Chair*** of the Technical Program Committee for the 7th IEEE International Workshop on Robotic and Sensors Environments – ROSE 2009, Lecco, Italy, 6-7 November 2009.

A4. Symposium Chair / Co-Chair

Symposium Co-Chair, Mobile Robotics Symposium, 42nd Mechanisms and Robotics Conference at the 2018 ASME International Design Engineering Technical Conferences (IDETC/CIE), August 26-29, 2018, Quebec City, Canada.

A5. Conference Technical Program Committees – Member

- ***Member*** of the Technical Program Committee for the 2019 IEEE International Conference on Mechatronics and Automation - IEEE ICMA 2019, Tianjin, China, 4-7 Aug. 2019.
- ***Member*** of the Technical Program Committee for the 2019 IEEE International Workshop on Robotic and Sensors Environments - ROSE 2019, Ottawa, Canada, 17-18 June 2019.
- ***Member*** of the Organizing Committee for the 2018 International Conference on Mechatronics Systems and Control Engineering – ICMSCE 2018, Amsterdam, Netherlands, 21-23 Feb. 2018.
- ***Member*** of the Technical Program Committee for the 2017 IEEE International Conference on Robotics and Biomimetics – ROBIO 2017, Macau SAR, China, 5-8 Dec. 2017.
- ***Member*** of the Technical Program Committee for the 2017 IEEE International Conference on Mechatronics and Automation - IEEE ICMA 2017, Takamatsu, Japan, 6-9 Aug. 2017.
- ***Member*** of the Organizing Committee for the 2017 International Conference on Mechatronics Systems and Control Engineering – ICMSCE 2017, Kayseri, Turkey, 2-4 Feb. 2017.
- ***Member*** of the Technical Program Committee for the 2016 IEEE International Conference on Robotics and Biomimetics – ROBIO 2016, Qingdao, China, 3-7 Dec. 2016.

- ***Member*** of the Technical Program Committee for the 2016 IEEE International Conference on Mechatronics and Automation - IEEE ICMA 2016, Harbin, China, 7-10 Aug. 2016.
- ***Member*** of the Technical Editorial Board for the 2016 CSME (Canadian Society for Mechanical Engineering) International Congress – Symposium on Control and Robotics, Kelowna, BC, Canada, 26-29 June 2016.
- ***Member*** of the Technical Program Committee for the 2015 IEEE International Conference on Robotics and Biomimetics – ROBIO 2015, Zhuhai, China, 6-9 Dec. 2015.
- ***Member*** of the Technical Program Committee for the 2014 IEEE International Conference on Robotics and Biomimetics – ROBIO 2014, Bali, Indonesia, 5-10 Dec. 2014.
- ***Member*** of the Technical Program Committee for the 12th IEEE International Symposium on Robotic and Sensors Environments – ROSE 2014, Timisoara, Romania, 16-18 Oct. 2014.
- ***Member*** of the Technical Program Committee for the 2014 IEEE International Conference on Mechatronics and Automation - IEEE ICMA 2014, Takamatsu, Tianjin, China, 3-6 Aug. 2014.
- ***Member*** of the Technical Program Committee for the 2014 Robotics Science and Systems Conference – RSS 2014, Berkeley, CA, USA, July 12–16, 2014.
- ***Member*** of the Technical Program Committee for the 2013 IEEE International Conference on Mechatronics and Automation - IEEE ICMA 2013, Takamatsu, Kagawa, Japan, 4-7 Aug. 2013.
- ***Member*** of the Technical Program Committee for the 2012 IEEE International Conference on Mechatronics and Automation - IEEE ICMA 2012, Chengdu, Sichuan, China, 5-8 Aug. 2012.
- ***Member*** of the Technical Program Committee for the 9th IEEE International Symposium on Robotic and Sensors Environments – ROSE 2011, Montréal, Québec, Canada, 17-18 Sep. 2011.
- ***Member*** of the Technical Program Committee for the 7th ASME/IEEE Int. Conf. on Mechatronics & Embedded Systems & Applications – MESA 2011, Washington, DC, August 28-31, 2011
- ***Member*** of the Technical Program Committee for the 2011 IEEE International Conference on Mechatronics and Automation - IEEE ICMA 2011, Beijing, China, 7-10 August 2011.
- ***Member*** of the Technical Program Committee for the 8th IEEE International Workshop on Robotic and Sensors Environments - ROSE 2010, Phoenix, Arizona, 15-16 October 2010.
- ***Member*** of the Technical Program Committee for the 6th IEEE International Workshop on Robotic and Sensors Environments - ROSE 2008, Ottawa, Canada, 17-18 October 2008.

A6. Expert Panels Chair/Reviewer and Proposal Reviewer

- ***Proposal Reviewer,*** Czech Science Foundation, Czech Republic 2022
- ***Panelist at a Study Section,*** National Institutes of Health (NIH) 2021
  SRO, Bioengineering, Technology, and Surgical Sciences (BTSS) Study Section
  Surgical Sciences, Biomedical Imaging and Bioengineering IRG
- ***Reviewer,*** Mitacs, Canadian Network of Centres of Excellence, Canada 2019
- ***Proposal Reviewer,*** National Research Foundation, Prime Minister's Office, Singapore 2019
- ***Proposal Reviewer,*** Natural Sciences & Eng Research Council of Canada (NSERC) 2018

- ***Proposal Reviewer,*** Israeli Ministry of Science and Technology — August 2018
  Topic: Robotics, Medical Devices and Big Data
- ***Panelist,*** IIHCC Industry Roundtable – Virginia Tech Applied Research Corp. — Nov. 2017
  Intelligent Infrastructure for Human-Centered Communities (IIHCC)
- ***Panelist,*** Red Teaming Round Table – Virginia Tech Applied Research Corp. — Nov. 2016
  Fully-Autonomous Drone Swarms; Office of the Deputy Assistant Secretary of the Army R&T
- ***Expert Reviewer***, Canada Foundation for Innovation (CFI) — Jul – Oct 2016
  2015 Innovation Fund (IF) Competition
- ***Panelist,*** National Science Foundation – National Robotics Initiative (NRI) — June 2016
  Division for Electrical, Communications and Cyber Systems (ECCS)
- ***Panelist,*** National Science Foundation – CISE/IIS/Robust Intelligence (NRI) — May 2015
  Division of Information and Intelligent Systems
- ***Proposal Reviewer,*** Canadian Institutes of Health Research (CIHR) — December 2014
- ***Panelist***, NSF CAREER – CMMI / Sensors, Dynamics & Control Programs — Sep 2014
- ***Chair of Expert Committee***, Canada Foundation for Innovation (CFI) — Jul – Oct 2014
  2015 Innovation Fund (IF) Competition
- ***Panelist***, National Science Foundation – CMMI / Dynamical Systems — May 2014
- ***Proposal Reviewer,*** National Science Foundation – CISE/Robust Intelligence — Feb 2014
- ***Proposal Reviewer,*** Natural Sciences & Eng Research Council of Canada (NSERC) 2012-2014
- ***Panelist***, U.S. Army Medical Robotics Product Line Review (PLR) Expert Panel — October 2012
  U.S. Army Telemedicine & Advanced Technology Research Center (TATRC)
- ***Panelist***, National Science Foundation – National Robotics Initiative (NSF-NRI) — June 2012
- ***Panel Chair***, National Defense Science & Eng. Graduate (NDSEG) Fellowship — Feb 2012
- ***Panelist***, Air Force Summer Faculty Fellowship Program (AF SFFP) — Jan 2010, 2011
- ***Panelist*** , NSF Graduate Research Fellowship Program (GRFP) — Feb 2010, 2011, 2012, 2013
- ***Panelist***, National Defense Science & Eng. Graduate (NDSEG) Fell. — 2010, 2011, 2012, 2015
- ***Panelist*** , ONR Summer Faculty Research Program (ONR SFRP) — Feb 2011, 2012
- ***Panelist*** , DOD Science, Mathematics & Research for Transformation (SMART) Defense Scholarship for Service Program — 2011, 2012, 2015, 2016
- ***Panelist*** , NASA Aeronautics Scholarship Program (NASA ASP) — Feb 2011, 2012, 2013
- ***Panelist*** , NSF East Asia and Pacific Summer Institutes (EAPSI) — Jan 2010
- ***Proposal Reviewer,*** *India Science & Technology Partnership (INSTP)* — April 2009
  Invited by the Smithsonian Institution, INDO-US Science & Technology Forum, Washington, DC

A7. Technical Editorial and Reviewer

Associate Editor - Journal May 2021 – Aug. 2022
Robotics

Technical Editor - Journal July 2016 – April 2021
IEEE/ASME Transactions on Mechatronics

Guest Editor - Journal June 2020 – April 2021
ASME Journal of Mechanisms and Robotics (special issue)

Guest Editor - Journal June 2019 – April 2020
ASME Journal of Mechanisms and Robotics (special issue)

Associate Editor - Journal Jan. 2018 – Jan. 2021
ASME Journal of Mechanisms and Robotics

Associate Editor - Journal Oct. 2017 – Dec. 2021
IEEE Robotics and Automation Magazine

Associate Editor - Journal Jan. 2011 – Jan. 2021
International Journal of Control, Automation and Systems

Associate Editor – Conference

IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS 2022)	2021–2022
IEEE International Conference on Robotics and Automation (ICRA 2018)	2017–2018
IEEE International Conference on Robotics and Automation (ICRA 2017)	2016–2017
ASME Dynamic Systems and Control Conference (DSCC 2017)	2017
IEEE International Conference on Robotics and Automation (ICRA 2016)	2015–2016
IEEE International Conference on Robotics and Automation (ICRA 2014)	2013–2014
IEEE International Conference on Robotics and Automation (ICRA 2013)	2012–2013

Journal Reviewer (2007 – current):

- IEEE Transactions on Robotics
- IEEE Robotics and Automation Letters
- IEEE/ASME Transactions on Mechatronics
- Transactions of the ASME, Journal of Mechanical Design
- Transactions of the ASME, Journal of Mechanisms and Robotics
- Transactions of the ASME, Journal of Dynamic Systems, Measurement and Control
- Journal of Field Robotics
- Journal of Robotics and Autonomous Systems
- Journal of Intelligent and Robotic Systems
- Robotica Journal
- Mechatronics Journal
- IEEE Sensors Journal
- IEEE Transactions on Systems, Man, and Cybernetics – Part A: Systems & Humans
- IEEE Transactions on Nanotechnology

- Journal of Intelligent Service Robots (ISR)
- Autonomous Robots
- Journal of Biomedical Microdevices

Conference Proceedings Reviewer (2004 – current):

- IEEE International Conference on Robotics and Automation (ICRA)
- IEEE International Conference on Intelligent Robots and Systems (IROS)
- IEEE International Workshop on Robotic and Sensors Environments (ROSE)
- IEEE International Conference on Mechatronics and Automation (ICMA)
- ASME International Mechanical Engineering Congress and Exposition (IMECE)
- Dynamic Systems and Control Conference (DSCC)
- IEEE Conference on Automation Science and Engineering (CASE)
- IEEE Conference on Decision and Control (CDC)
- IEEE RAS/EMBS Int. Conference on Biomedical Robotics and Biomechatronics (BioRob)
- IEEE/ASME International Conference on Advanced Intelligent Mechatronics (AIM)
- American Control Conference
- ASME International Design Engineering Technical Conferences (IDETC/CIE)
- ASME/IFToMM International Conference on Reconfigurable Mechanisms and Robots
- IASTED Conference on Robotics and Applications

Book Proposals Reviewer

- Fundamentals and Applications of Nanopositioning Technologies — Mar. 2014
  Publisher: Springer; Edited by: Changhai Ru, Xinyu Liu, and Yu Su

A8. Professional Meetings, Workshops, Etc. Chaired or Organized

- ***Session Chair,*** Technical Session: "Prosthetics, exoskeletons and Rehabilitation", *Proc. of the 2023 IEEE International Conference on Robotics and Automation (ICRA2023)*, London, UK**,** May 29-June 2, 2023.

- ***Session Chair,*** Technical Session: "Novel Mechanisms, Robots, and Applications", Topic: TBD1"; *ASME IDETC/CIE 2021*, *46th Mechanisms & Robotics Conference,* St. Louis, Missouri, Aug. 14-17, 2022.

- ***Session Chair,*** Technical Session: "Novel Mechanisms, Robots, and Applications", Topic: TBD2"; *ASME IDETC/CIE 2021*, *46th Mechanisms & Robotics Conference,* St. Louis, Missouri, Aug. 14-17, 2022.

- ***Session Chair,*** Technical Session: "Motion Planning", Topic: "Dynamics, and Control of Robots"; *ASME IDETC/CIE 2021*, *45th Mechanisms & Robotics Conference,* Virtual Conference, Aug. 17-19, 2021.
- ***Session Chair,*** Technical Session: "Ions, Hydrogels, LC Elastomers, and Coiled Artificial Muscle Heat Pumping", *2020 SPIE Smart Structures and Nondestructive Evaluation (EAPAD 2020) Conference*, Anaheim, CA, April 26-30, 2020.

- ***Session Chair,*** Technical Session: "Autonomous Vehicle Navigation II", *2019 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, Macau, China, November 4-8, 2019.

- ***Session Organizer,*** Technical Session: “Humanlike Robots - The Ultimate Challenge to Biomimetics”, *ASME IDETC/CIE 2018*, *43rd Mechanisms & Robotics Conference,* Anaheim, CA, Aug. 18-21, 2019.

- ***Session Chair,*** Technical Session: “Motion Planning”, Topic: “Mobile Robotics”; *ASME IDETC/CIE 2018*, *42nd Mechanisms & Robotics Conference,* Quebec City, Canada, Aug. 26-29, 2018.

- ***Session Co-Chair,*** Technical Session: “Upper Extremity”, Topic: “Medical & Rehabilitation Robotics”; *ASME IDETC/CIE 2018*, *42nd Mechanisms & Robotics Conference,* Quebec City, Canada, Aug. 26-29, 2018.

- ***Session Chair,*** Technical Session: “Robot Design and Development”, *2018 International Conference on Mechatronics Systems and Control Engineering – ICMSCE 2018*, Amsterdam, Netherlands, 21-23 Feb. 2018.

- ***Session Co-Organizer,*** Technical Session: “Design and Control of Robots, Mechanisms and Structures I”, Track: “Dynamics, Vibration, and Control”; Topic: “Design and Control of Robots, Mechanisms and Structures”; *ASME International Mechanical Engineering Congress and Exposition – IMECE 2017*, Tampa, FL, 3-9 Nov. 2017.

- ***Session Co-Chair,*** Technical Session: “Unmanned, Ground and Surface Robotics I”, 2017 ASME Dynamic Systems and Control Conference – DSCC 2017, Tysons Corner, VA, 11-13 Oct. 2017.

- ***Session Co-Chair,*** Technical Session: “Unmanned, Ground and Surface Robotics III”, 2017 ASME Dynamic Systems and Control Conference – DSCC 2017, Tysons Corner, VA, 11-13 Oct. 2017.

- ***Session Chair,*** Technical Session: “Mobile Robots”, *2017 IEEE Conference on Control Technology and Applications,* Kohala Coast, Hawai'i, Aug. 27–30, 2017

- ***Session Co-Chair,*** Technical Session: “Assistive Devices”, Topic: “Medical & Rehabilitation Robotics”; *ASME IDETC/CIE 2017*, *41st Mechanisms & Robotics Conference,* Cleveland, OH, Aug. 6-9, 2017.

- ***Session Chair,*** Technical Session: “Mobile Robots”, Topic: “Novel Mechanisms, Robots and Applications”; *ASME IDETC/CIE 2016*, *40th Mechanisms & Robotics Conference,* Charlotte, NC, Aug. 21-24, 2016.

- ***Session Organizer,*** Technical Session: “Mobile Robots”, Topic: “Novel Mechanisms, Robots and Applications”; *ASME IDETC/CIE 2016*, *40th Mechanisms & Robotics Conference,* Charlotte, NC, Aug. 21-24, 2016.

- ***Session Co-Organizer,*** Technical Session: “Modeling, Analysis, and Estimation”, Topic: “Mobile Robots, Motion Planning, Dynamics and Control”; *ASME IDETC/CIE 2016*, *40th Mechanisms & Robotics Conference,* Charlotte, NC, Aug. 21-24, 2016.

- ***Session Chair,*** Technical Session: “Modeling and Control of Mobile Robots”, Topic: “Mobile Robots and Cable-Driven Systems”; *ASME IDETC/CIE 2015*, *39th Mechanisms & Robotics Conference,* Boston, MA, Aug. 2-5, 2015.

- ***Session Chair,*** Technical Session: “Developments in sUAV: From Payload to Safety”, Topic: “Small Unmanned Aerial Vehicle Technologies and Applications”; *ASME IDETC/CIE 2015*,

ASME/IEEE International Conference on Mechatronic and Embedded Systems and Applications (MESA), Boston, MA, Aug. 2-5, 2015.

- ***Session Chair,*** Technical Session: "Bioinspired Mechanisms and Robots II", Topic: "Symposium on Biologically Inspired and Health Motivated Mechanisms and Robotics"; *ASME IDETC/CIE 2014*, *38th Mechanisms & Robotics Conference,* Buffalo, NY, Aug. 17-20, 2014.

- ***Session Co-Chair,*** Technical Session: "Surgical and Rehabilitation Robotics", Topic: "Symposium on Biologically Inspired and Health Motivated Mechanisms and Robotics"; *ASME IDETC/CIE 2014*, *38th Mechanisms & Robotics Conf.,* Buffalo, NY, Aug. 17-20, 2014.

- ***Session Chair,*** Technical Session: "Collaborative Robotics & Distributed Sensing"*, IEEE International Symposium on Robotic & Sensors Environments – ROSE 2013*, Washington, DC, Oct. 21-23, 2013.

- ***Session Chair,*** Technical Session: "Robotic Dynamics", Track: "Dynamic Systems and Control"; Topic: "Dynamics and Control of Mechanisms and Robots"; *ASME International Mechanical Engineering Congress & Exposition – IMECE 2011*, Denver, CO, 11-17 Nov. 2011.

- ***Session Organizer,*** Technical Session: "Biomedical Mechatronics", Track: "Mechatronics & Intelligent Machines"; Topic: "Symposium on Biomedical Mechatronics"; *ASME International Mechanical Engineering Congress and Exposition – IMECE 2011*, Denver, CO, 11-17 Nov. 2011.

- ***Session Organizer,*** Technical Session: "Robotics, Actuators and Sensors V", Track: "Mechatronics & Intelligent Machines"; Topic: "Symposium on Robotics, Actuators and Sensors"; *ASME Int'l Mechanical Eng. Congress & Expo. – IMECE 2011*, Denver, CO, 11-17 Nov. 2011.

- ***Session Chair,*** Technical Session: "Localization Systems"*, IEEE International Symposium on Robotic & Sensors Environments – ROSE 2011*, Montreal, Quebec, Canada, Sep. 17-18, 2011.

- ***Session Chair,*** Technical Session: "Robot Control", Track: "Dynamic Systems and Control"; Topic: "Symposium on Dynamics and Control of Mechanisms and Robots"; *ASME International Mechanical Engineering Congress and Exposition – IMECE 2010*, Vancouver, BC, 12-18 November 2010.

- ***Session Co-Chair,*** Technical Session: "Robot Control II", Track: "Dynamic Systems and Control"; Topic: "Symposium on Dynamics and Control of Mechanisms and Robots"; *ASME International Mechanical Engineering Congress and Exposition – IMECE 2010*, Vancouver, BC, 12-18 November 2010.

- ***Session Chair,*** Technical Session: "Wireless and Distributed Sensing Networks*", IEEE International Workshop on Robotic and Sensors Environments – ROSE 2010*, Phoenix, Arizona, 15-16 October 2010.

- ***Session Co-Chair,*** Technical Session: "Vibration and Control of Mechanical Systems", *ASME International Mechanical Engineering Congress and Exposition – IMECE 2009*, Lake Buena Vista, FL, 13-19 November 2009.

A9. Advisory/Technical Committee Memberships

- **Member**, IEEE Robotics and Automation Society, Mechanisms and Design Technical Committee (TC) — 2017–Present

- **Elected Voting Member**, ASME Design Engineering Division, — 2018–2022

Mechanisms and Robotics Technical Committee (TC)

- **Program Advisory Committee**, Robotics & Mechatronics Systems Eng. Program 2011–Present University of Detroit, Mercy

A10. Professional Memberships

- American Society of Mechanical Engineers (ASME) 2002 – Present
- Institute of Electrical & Electronics Engineers (IEEE) 2002 – Present
- IEEE Robotics and Automation Society (RAS) 2009 – Present
- Association for Unmanned Vehicle Systems International (AUVSI) 2008 – Present
- Society of Automotive Engineers (SAE) 2008 – Present
- The Israeli Robotics Association (IROB) 2018 – Present
- Robotics Technology Consortium (RTC) 2009 – 2014

B. Departmental Service and Administrative Assignments

Virginia Tech

- **Member,** RADS Major Subcommittee 2022 – 2022
  Robotics, Autonomous, and Dynamical Systems (RADS)
  Mechanical Engineering Department
- **Member,** Graduate Program Committee 2015 – 2022
  Mechanical Engineering Department
- **Chair,** Faculty Search Committee (Dynamic Systems and Control) 2017 – 2018
  Mechanical Engineering Department
- **Chair,** Faculty Search Committee (Robotics Perception) 2017 – 2018
  Mechanical Engineering Department
- **Member,** Ad Hoc (P&T and TAC) Committee 2017 – 2019
  Mechanical Engineering Department
- **Coordinator,** Thrust Area Committee (TAC) 2017 – 2018
  Robotics, Autonomous, and Dynamical Systems (RADS)
  Mechanical Engineering Department
- **Mentor for Junior Faculty** 2018 – 2019
  Mechanical Engineering Department
- **Representative Member,** Thrust Area Committee (TAC) 2016 – 2019
  Robotics, Autonomous, and Dynamical Systems (RADS)
  Mechanical Engineering Department
- **Member,** Faculty Search Committee (Dynamic Systems & Control - Perception) 2016 – 2017
  Mechanical Engineering Department
- **Member,** Faculty Search Committee (Energy Area) 2015 – 2016
  Mechanical Engineering Department

George Washington University

- Member, Sub-Committee for the Undergraduate Design Curriculum 2009 – 2015
- ABET Design Subcommittee 2010 – 2015
- Member, Academic Standards Committee 2009 – 2015
- Member, Laboratory Committee 2009 – 2015
- Member, Steering Committee 2009 – 2015
  Center for Biomimetics & Bioinspired Engineering (COBRE)
- Member, Faculty Search Committee 2010 – 2011
  Dept. of Mechanical & Aerospace Engineering, GWU
- Member, Faculty Search Committee 2009 – 2010
  Dept. of Computer Science, GWU
- Departmental Secretary, MAE Faculty Meetings 2009 – 2010

C. School/College Service and Administrative Assignments

Virginia Tech

- Faculty Judge, 2022 Senior Design Competition Expo April 2022
- Faculty Judge, 2021 Senior Design Competition Expo April 2021
- Faculty Judge, Torgersen Graduate Research Award Competition May 2019
- Faculty Judge, 2019 Senior Design Competition Expo May 2018
- Faculty Judge, 2018 Senior Design Competition Expo May 2018
- Faculty Judge, 2017 Senior Design Competition Expo May 2017
- Faculty Judge, 2016 Senior Design Competition Expo May 2016

George Washington University

- Faculty Judge, 2015 R&D SEAS Showcase Feb 2015
- Faculty Judge, The Pelton Award for Outstanding Senior Project May 16, 2012
- Faculty Judge, 2012 R&D SEAS Showcase Feb 27, 2012
- Faculty Panelist, SEAS New Faculty Orientation August 24, 2011
- Faculty Panelist, SEAS New Faculty Orientation August 25, 2010
- Member, SEAS Biomedical Engineering (BME) Interest Group 2009 – 2015

- Member, Science and Engineering Hall (SEH) Planning Committee 2009 – 2015

- Member, SEAS Educational Initiatives (SEI) Committee Spring 2009
  Undergraduate Programs in Robotics, and Energy & Sustainability

- Affiliate Member, GW Institute for Nanotechnology (GWIN) 2013 – 2015

- Affiliate Member, GW Institute for Biomedical Engineering (GWIBE) 2009 – 2015

- Participated in various School of Engineering & Applied Science recruiting events and orientations for Graduate and Undergraduate students, including:
  - Graduate / Undergraduate Open Houses
  - Undergraduate recruiting events and orientations

  As part of those activities, students tour the Robotics & Mechatronics Lab (RML) and I give talks about educational and research opportunities in SEAS through various demonstrations of research ongoing in RML.

D. University Service and Administrative Assignments

George Washington University

- Member, Faculty Governance Working Group on Appointment, Promotion & Tenure 2014–2015

- Member, Faculty Senate Committee on Professional Ethics & Academic Freedom 2012–2015

- Judging Team Member, GWU Research Day Apr 2014

- Judging Team Captain, GWU Research Day Apr 2013

- Reviewer, George Washington University Facilitating Fund UFF/Dilthey Award Jan. 2012, 2013

- Organizer, Robotics Workshops at the Science, Apr 2011, 2012, 2013, 2014
  Technology & Engineering Day
  Virginia Science and Technology Campus, GWU
  Workshop title: “Greater than the Sum of its Parts: Integrating a Robotic System”

Dr. Pinhas Ben-Tzvi, Ph.D., P.E., FASME, SMIEEE
5503 Chestermill Ct
Fairfax, VA 22030

Expert Testimony List

United States District Court, Southern District of Ohio
Stryker Corporation et al. (Plaintiff)* v. Ferno-Washington, Inc. et al. (Defendant), Civil Action No. 1:22-cv-00588-MRB, Patent Infringement Case Pertaining to US Patents 7,398,571, RE44,884, 7,725,968, 8,056,950; 10,058,464; D794,205; D833,623; D875,950; 11,090,207, and 10,568,787; 11,458,050
Declaration to be prepared

United States District Court, Southern District of Mississippi, Eastern Division
Caspa Solutions LLC (Plaintiff)* v. Howard Industries, Inc. (Defendant), Civil Action No. 2:22-cv-00065-HSO-BWR, Patent Infringement Case Pertaining to US Patents 7,594,668, 8,215,650, 8,109,527, D762,339, 9,039,016, 10,159,337, 10,299,582.
Two Declarations

United States International Trade Commission (ITC)
In the Matter of Certain Electronic Candle Products and Components Thereof (Investigation No. 337-TA-1195)
L&L Candle Company LLC and Sotera Tschetter, Inc. (Complainants) v. Sterno Products *et al.* (Defendants)*
Provide expert opinion on patentability/obviousness

United States District Court, District of Nebraska
Hartford Fire Insurance Company (Plaintiff)* v. McLeod Software Corporation (Defendant), Hartford Insurance Claim # CP0017674514, Court suit not yet filed
Technical Report

United States District Court, District of New Jersey
IOTTIE INC. and HSM CO., LTD., (Plaintiffs)* v. MERKURY INNOVATIONS (Defendant), Civil Action No. 2:15-cv-06597-KM-JBC (D.N.J.) Pertaining to US Patent 8,627,953
Declaration, Deposition

United States Patent and Trademark Office, Before the Patent Trial and Appeal Board
Wagner Spray Tech (Plaintiff)* v. Graco Inc. (MN) (Defendant); Not yet filed
Patent No. at Issue: 9,675,982
Declaration, Provide expert opinion on patentability/obviousness

In the Court of Queen's Bench of Alberta, Canada
DFI Corporation (Plaintiff)* v. Sauer Danfoss, Inc. and Norcan Fluid Power Limited (Defendant), Court File Number 0903-16237
Site Inspection/Field Investigation, Expert Report

United States International Trade Commission (ITC)
In the Matter of Certain Hospital Beds and Components Thereof (Investigation No. 337-TA-987)
Stryker (Complainant)* v. Umano Medical Inc. and Umano Medical World Inc. (Defendants)
Two Declarations, Deposition

United States Patent and Trademark Office, Before the Patent Trial and Appeal Board (IPR)
SATA GmbH & CO. KG (Petitioner)* v. ANEST IWATA CORPORATION (Patent Owner), Case No. IPR2013-00111 (Patent 6,494,387)
Declaration, Deposition

In the Superior Court of the State of Delaware, In and For Sussex County
Patrick Black (Plaintiff) v. Chromascape, Inc. dba Amerimulch; Lenze Americas Corp., Southtech Industries, Inc. (Defendant)*, Civil Case No. S13C-04-018 RFS
Site Inspection/Field Investigation, Expert Report

EXHIBIT C

MATERIALS CONSIDERED

ECF No. 24 Amended Complaint & Exhibits

ECF No. 40 Motion Control's Answer, Counterclaim, and Affirmative Defense to Vincent's First Amended Complaint

2023.11.01 Defendants' Initial Non-Infringement Contentions and Exhibit 1

2023.10.04 Vincent Systems' Initial Infringement Contentions and Exhibit A

2023.12.11 Defendants' Invalidity Contentions and Exhibits

2024.01.03 Plaintiff's Validity and Enforceability Contentions

2024.01.22 Vincent Systems' 1st Supplemental Initial Infringement Contentions and Exhibit A

2024.03.01 Defendants' Supplemental Exchange of Final Claim Constructions and Exhibit A

MC0001111
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